Walleye Studies in the Peace-Athabasca Delta, 1978

Alberta
PEACE-ATHABASCA
MONITORING COMMITTEE

WALLEYE STUDIES IN THE PEACE-ATHABASCA DELTA, 1978

By

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LGL LIMITED

For

Fisheries Subcommittee

Peace-Athabasca Delta

Monitoring Committee

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ABSTRACT

A study was initiated in 1978 to locate spawning areas of walleye in the Peace-Athabasca Delta (other than Richardson Lake), assess their significance as spawning areas in comparison to Richardson Lake and to compare various biological characteristics of walleye found in the different areas. Mature walleye were captured in areas other than the Richardson Lake system. Eight- and 9-year-old walleye dominated samples obtained from Richardson Lake and the commercial fishery at Big Point, Lake Athabasca. Richardson Lake walleye are relatively slow growing and exhibit a late age at first maturity.

The exploitation rate of Richardson Lake walleye by the commercial fishery was 2.3% in 1978, which is comparable to the rates obtained in 1971 (5.0%) and 1972 (8.4%) in the same area. Growth rates and age at first maturity indicate that Richardson Lake walleye are presently not being overexploited by the commercial fishery. Walleye from areas other than the Richardson Lake system contributed to the commercial fishery. Of the walleye tagged at Quatre Fourches in 1978, 9.4% were recaptured in the commercial fishery. Walleye tagged in 1972 and 1977 in the Richardson Lake system were recaptured in 1978 in the same system.

Based on extrapolations from trawl net catches, 1.4, 1.2 and 1.5 million young-of-the-year walleye were estimated to have been produced in Lake Claire, Mamawi Lake and Richardson Lake, respectively. The Claire-Mamawi lakes system was estimated to have produced 1.7 times as many young-of-the-year walleye as Richardson Lake in 1978. Production of young-of-the-year in the Claire-Mamawi lakes system appears to vary more from year to year than in the Richardson Lake system.

ACKNOWLEDGEMENTS

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Many people contributed their time and effort to this project. Field assistants were T. Byers, G.W. Clarke, G.R.A. Ebel and S.A. Pidge of LGL Limited, and A. Courtorielle, E. Courtorielle, J. Courtorielle, D. Marcel, R. Marcel, W. Marcel, C. Mercredi and E. Whiteknife of Fort Chipewyan.

J. Bergeron of Contact Airways and L. Yanick of Noralta Flights informed us of ice conditions along the Athabasca River and in the Peace-Athabasca Delta in May. R. Armit, a domestic fisherman and trapper at Blanche Lake, contributed valuable information on gill net catches in that lake. J.W. Anderson and S. Flett of Alberta Environment provided hydrological data and assisted in numerous other capacities. Helpful discussions were conducted with K.G. Dietz, Alberta Fish and Wildlife Division, concerning the use of pelvic fin rays to determine walleye ages. The Canadian Wildlife Service allowed us to store equipment in its warehouse at Fort Chipewyan, and the Alberta Fish and Wildlife Division permitted us to use its cabin at Jackfish.

T. Byers and G.W. Clarke assisted with the analyses of data, and G.W. Clarke 'read' walleye pelvic fin rays. D.A. Birdsall and A.D. Sekerak of LGL Limited reviewed and edited earlier drafts of this report. Figures which appear in this report were drafted by K. Bruce and D. Hollingdale. Several drafts of the report were typed by C. Furlong, D. Whitford, G. Wylie and J. Bjornson.

Special mention is made of the domestic, commercial and sport fishermen and A.O.S.E.R.P. fisheries biologists who contributed valuable information to the study by returning fish tags to us.

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INTRODUCTION

The completion of the Bennett Dam in 1968 interrupted natural water regimes in the Peace-Athabasca Delta (Figure 1) and threatened to permanently alter the environment of the Delta. The Bennett Dam, which is located in British Columbia 1170 km upstream from the Delta, controls approximately 50% of the flow in the Peace River near the Delta (Peace-Athabasca Delta Project Group 1973). Following completion of the dam, the natural flood levels in the Peace River were reduced by as much as 3.7 m. This reduction in Peace River flow led to a reduction of the annual flooding in the Delta and had far-reaching effects on the ecology of the Delta system. The problem of decreasing water levels in the Delta was deemed so urgent that the Peace-Athabasca Delta Project Group was established in January 1971, and a number of ecological and hydrological studies were initiated in the same year.

One of these studies involved the assessment of the potential effects of the altered water regimes on walleye (*Stizostedion vitreum*) spawning in Richardson Lake (Figure 2) (Bidgood 1973). Earlier studies (Bidgood 1965, 1968 and 1971) had shown that Richardson Lake is an important spawning area for walleye in the Peace-Athabasca Delta. Results of tagging studies, particularly that of Dietz (1973), indicated that walleye that spawn in Richardson Lake contribute significantly to commercial walleye fisheries conducted in Lake Athabasca in both Alberta and Saskatchewan.

On the basis of abundant biological and hydrological information collected between 1971 and 1972, it was subsequently recommended by the Peace-Athabasca Delta Project Group (1973) that water control structures be built on the Rivière des Rochers and Revillon Coupé to decrease the rate of water flow out of Lake Athabasca and the Delta during most of the year. Ott and Sekerak (1976) studied the spawning success and the age composition of walleye in Lake Athabasca and Richardson Lake in 1975 prior to the construction of these control structures. Submerged weirs were completed at Little Rapids on the Rivière des Rochers in the fall of 1975, and on the Revillon Coupé (Figure 2) in the spring of 1976.

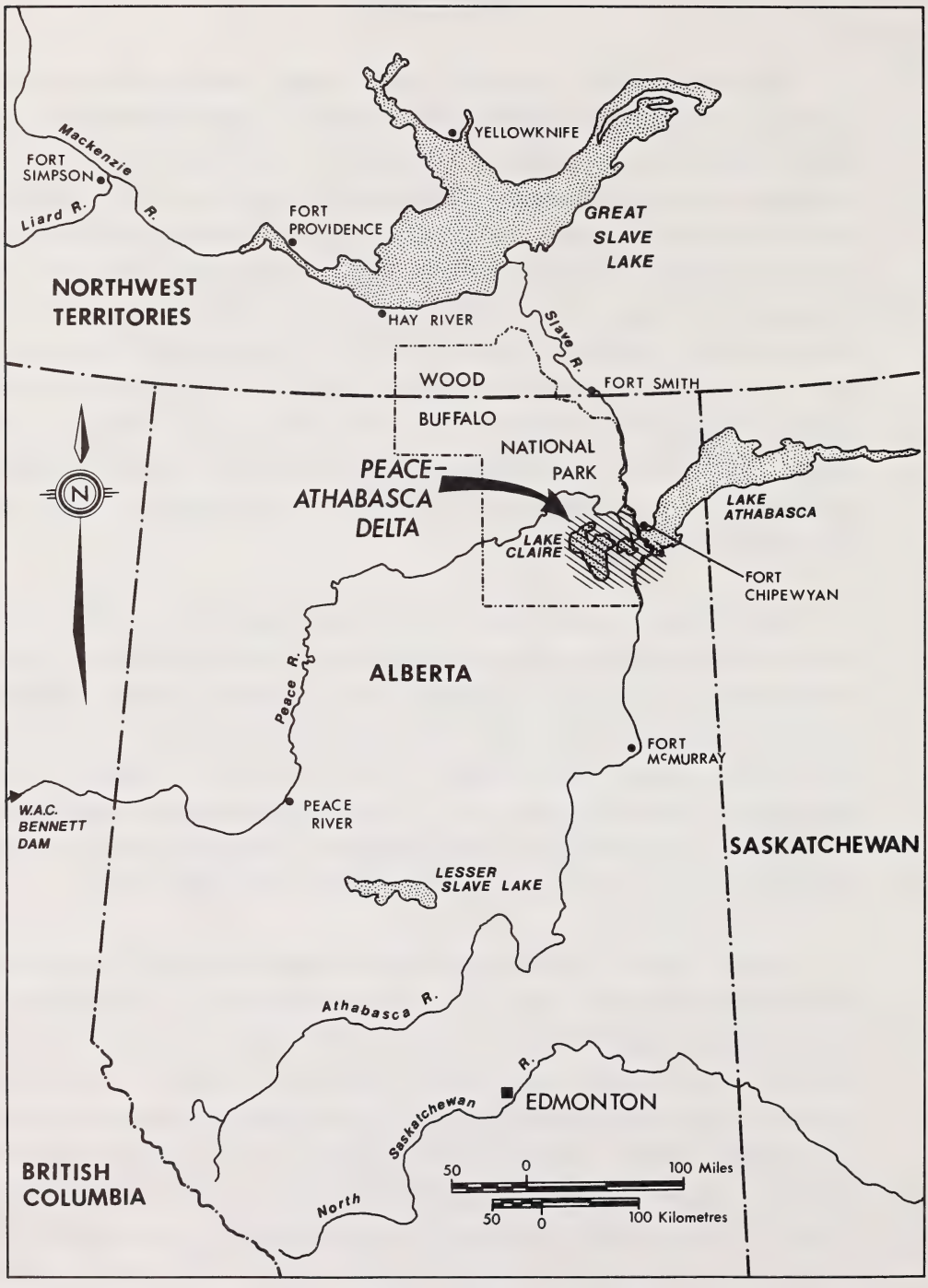


FIGURE 1. The Peace-Athabasca Delta.

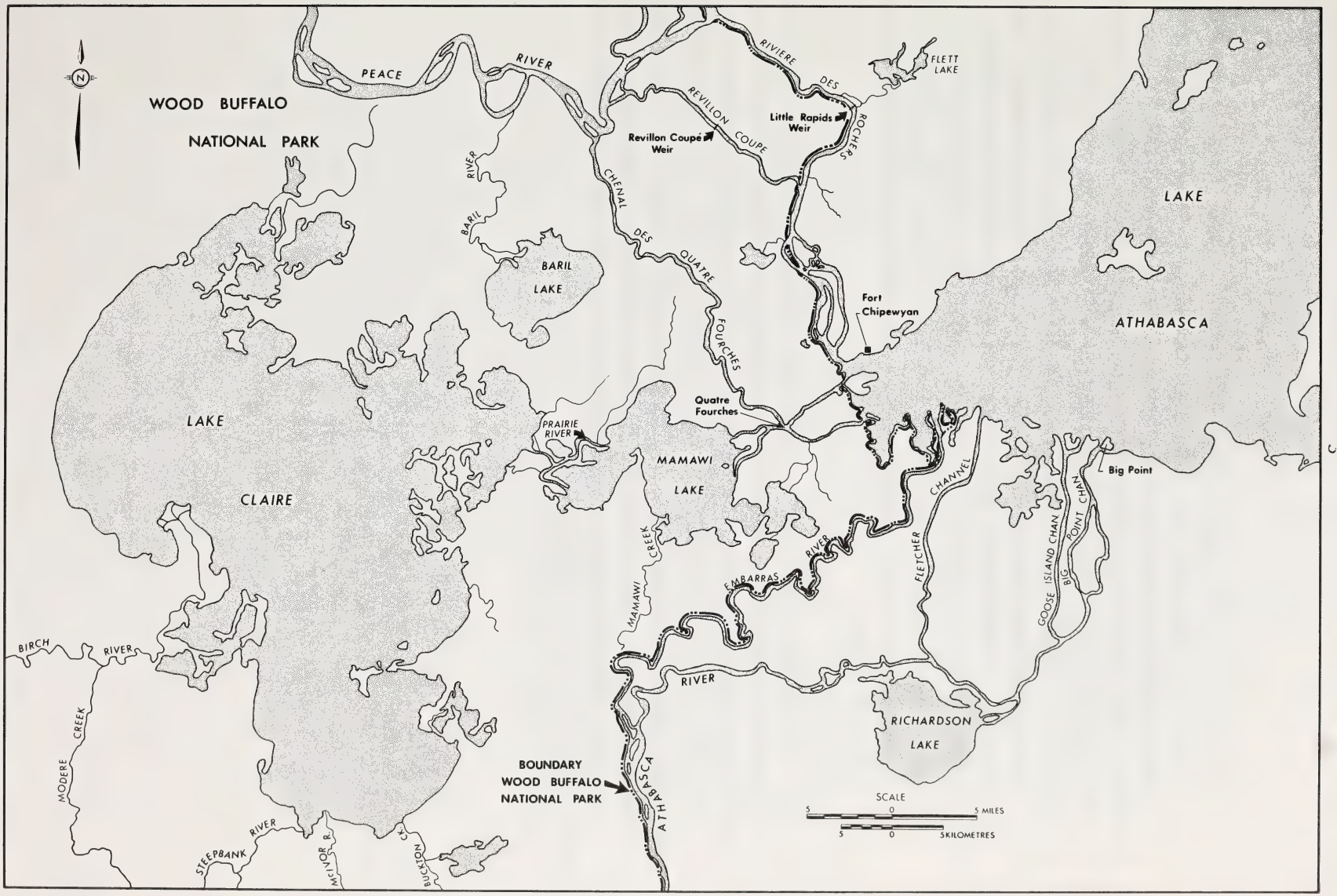


FIGURE 2. The Peace-Athabasca Delta, Showing Locations of the Water Control Structures on the Rivière des Rochers and the Revillon Coupé.

Summers (1978) conducted research in 1977 to assess the potential effects on Richardson Lake walleye of altered water levels caused by the two control structures. Results of that study indicated that, although Richardson Lake walleye contribute significantly to the commercial walleye fishery conducted during late spring and early summer in the vicinity of Big Point, Lake Athabasca (Figure 2), walleye which spawn in other areas within the Peace-Athabasca Delta make major contributions as well to this fishery. The capture of early-stage young-of-the-year walleye in Lake Claire and Mamawi Lake in 1971 (Fernet 1971) and 1977 (Kristensen 1978), and along the northern shore of Lake Athabasca in 1977 (Kristensen 1978) suggested that walleye spawn in these areas; but the significance of these areas is unknown.

This study was therefore initiated to more specifically locate walleye spawning areas in the Peace-Athabasca Delta (other than Richardson Lake), assess their significance as spawning areas in comparison to Richardson Lake and to compare various biological characteristics of walleye found in the different areas. These included age structure, growth and reproductive parameters of spawners and size of young-of-the-year. Information on the age structure and growth of walleye captured in the 1978 commercial fishery at Big Point was also collected.

STUDY AREA

The Peace-Athabasca Delta--one of the largest freshwater deltas in the world--encompasses an area of approximately 3800 km^2 (Peace-Athabasca Delta Project Group 1973). Most of the Delta is situated within Wood Buffalo National Park at the western end of Lake Athabasca (see Figure 1). The Delta consists of predominantly flat terrain, formed primarily by the deposition of silt that has been carried into the area by the Peace, Athabasca and Birch rivers. Outcrops of Precambrian granite, which delimit the western edge of the Canadian Shield, occur in the eastern and northeastern areas of the Delta.

The active portion of the Delta includes major rivers, smaller streams and open basin lakes (Dirschl 1973). The four major lakes within the Delta (Claire, Mamawi, Richardson and Baril [see Figure 2]) are extremely shallow, ranging in depth from 0.6 to 3.0 m (Peace-Athabasca Delta Project Group 1973). The two largest lakes, Lake Claire and Mamawi Lake, are approximately 1435 km^2 and 164 km^2 in area, respectively; Richardson Lake encompasses a surface area of approximately 75 km^2. The very shallow western end of Lake Athabasca is also included in the Delta. The semi-active portion of the Delta includes many shallow perched basins and oxbow lakes; closed basins located in higher and older areas comprise the inactive part of the Delta (Dirschl 1973).

This study was conducted in several waterbodies within the Peace-Athabasca Delta--specifically, in the following areas: Lake Claire, Mamawi Lake, Lake Athabasca, Richardson Lake, Limon Lake, Blanche Lake, the Prairie River, channels associated with the Chenal des Quatre Fourches, the Athabasca River, Jackfish Creek, Keane Creek, the Richardson River and the Birch River (Figure 3).

FIGURE 3. Locations of Gill Net Sampling Stations in the Peace-Athabasca Delta, 1978.

METHODS

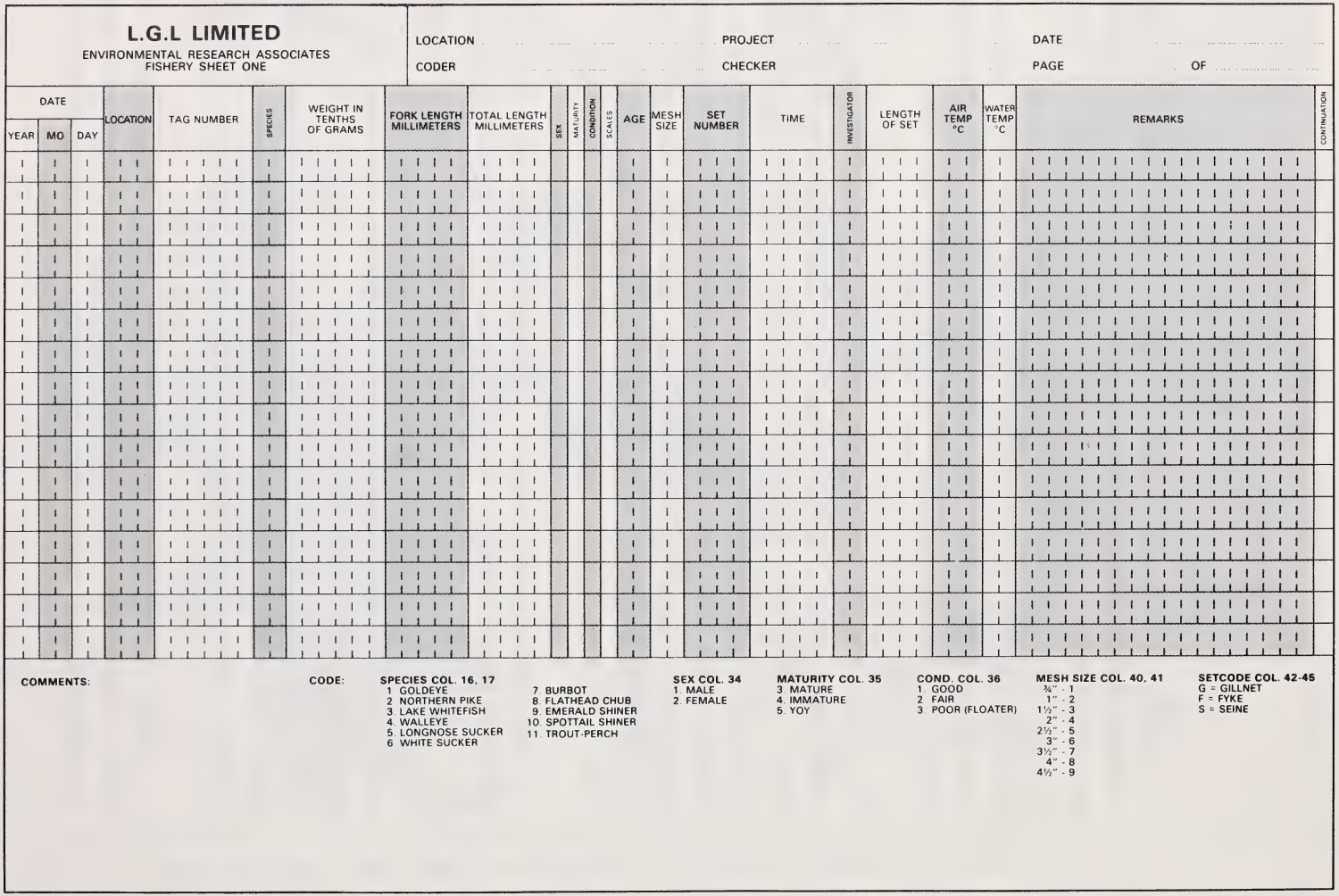
Gill Netting

Under-ice gill netting was conducted at Quatre Fourches, along the northern shore of Lake Athabasca and at the confluence of Jackfish Creek and the Athabasca River (see Figure 3) from 9-17 April 1978. Nets were also set under the ice in the Prairie River on 11 and 12 April. Gangs of three monofilament gill nets (3.8-, 6.4- and 8.9-cm stretched mesh) were used during this period. The individual nets were 15.2 m long and 2.5 m deep.

Open-water gill netting was conducted in Richardson Lake, Jackfish Creek, Blanche Lake, Limon Lake and the Richardson River (see Figure 3) from 19-28 May 1978. Drifting ice prevented gill netting in other areas of the Delta until 31 May. Gill nets were set in Lake Athabasca, Lake Claire, Mamawi Lake, the Prairie River and at Quatre Fourches from 31 May-4 June 1978. Gangs of four monofilament gill nets (3.8-, 6.4-, 8.9- and 10.2-cm stretched mesh) were used during May and June. Individual nets were of the same size as those used during April.

Gill netting was conducted in locations where water depth and current permitted proper setting. During the under-ice gill netting period, nets were set in locations through which mature walleye could be expected to travel en route to spawning grounds. During the open-water gill netting period, nets were set primarily in the Richardson Lake area and in locations where young-of-the-year (Y-O-Y) walleye were captured in 1977 (Kristensen 1978). Nets were set for varying lengths of time, depending on the purpose of the sets and on the catch rates of fish. If fish were to be tagged and released, the sets were of short duration (usually less than 1 h).

Data collected from the gill net sets were coded onto data forms in order to ensure that information collection was standardized. Figure 4 illustrates one of these forms and the types of data that were recorded for



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FISHERY SHEET ONE

LOCATION . . . . . PROJECT . . . . . DATE . . . . .
CODER . . . . . CHECKER . . . . . PAGE . . . . . OF . . . . .

DATE YEAR	DATE MO	DATE DAY	LOCATION	TAG NUMBER	SPECIES	WEIGHT IN TENTHS OF GRAMS	FORK LENGTH MILLIMETERS	TOTAL LENGTH MILLIMETERS	SEX	MATURITY	CONDITION	SCALES	AGE	MESH SIZE	SET NUMBER	TIME	INVESTIGATOR	LENGTH OF SET	AIR TEMP °C	WATER TEMP °C	REMARKS	CONTINUATION

COMMENTS:

CODE:

SPECIES COL. 16, 17
1. GOLDEYE
2. NORTHERN PIKE
3. LAKE WHITEFISH
4. WALLEYE
5. LONGNOSE SUCKER
6. WHITE SUCKER
7. BURBOT
8. FLATHEAD CHUB
9. EMERALD SHINER
10. SPOTTAIL SHINER
11. TROUT-PERCH

SEX COL. 34
1. MALE
2. FEMALE

MATURITY COL. 35
3. MATURE
4. IMMATURE
5. YOY

COND. COL. 36
1. GOOD
2. FAIR
3. POOR (FLOATER)

MESH SIZE COL. 40, 41
¾" - 1
1" - 2
1½" - 3
2" - 4
2½" - 5
3" - 6
3½" - 7
4" - 8
4½" - 9

SETCODE COL. 42-45
G = GILLNET
F = FYKE
S = SEINE

FIGURE 4. Data Sheet Used to Record Gill Net Catches.

all fish captured in gill nets. It should be noted that weights of walleye were recorded to the nearest ounce and converted to grams for subsequent data analyses.

Trawl Netting

Sampling for Y-O-Y walleye was conducted in locations shown in Figure 5 from 23 June-11 July 1978. Methods were similar to those used by Ott and Sekerak (1976) and Kristensen (1978) to sample Y-O-Y walleye and Y-O-Y goldeye (*Hiodon alosoides*), respectively. Two nets were towed--one on each side of a 6-m boat that was powered by a 14.9 kW engine, which was operated at full throttle for 2, 5 or 10 min at each sampling station. During part of the sampling period in the Richardson Lake/Jackfish Creek area, a single net mounted in front of the boat (as described by Summers [1978]) was used. Each trawl net was constructed of aluminum tubing that formed a square mouth and a bag made of 3.2-mm oval mesh nylon net that tapered to a point.

In lakes, trawls were conducted as close to the shore as possible in water that was between 0.9 and 1.0 m deep so that the trawl nets almost touched the substratum. In rivers, trawls were also conducted as close to the shore as possible, with the net nearest the shoreline (when two nets were used) in water that was approximately 1.0 m deep. Sampling sites were chosen on the basis of sites sampled by Ott and Sekerak (1976) in 1975 and Kristensen (1978) in 1977.

Data collected for each trawl were coded onto data forms--one of these forms is illustrated in Figure 6. The total lengths of all Y-O-Y walleye captured were recorded as well on these data forms.

Tagging

Tagging was conducted during both the April and the May-June gill netting period. Eight species of fish were tagged with numbered, international-orange, nylon anchor tags. Tags were applied with a cartridge-fed model No. FDM-68 tagging gun (Floy Tag and Manufacturing Company,

FIGURE 5. Locations of Trawl Net Sampling Stations in the Peace-Athabasca Delta, 1978.

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FISHERY SHEET TWO

LOCATION ..... PROJECT ..... DATE .....
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DATE			LOCATION	TRAWL #	SPECIES	NO. OF FRY	METHOD	TIME	INVESTIGATOR	TRAWL LENGTH TIME	WATER DEPTH METERS	DISTANCE FROM SHORE METERS	TRAWL SPEED CM/SEC	CURRENT DIRECTION	CURRENT VELOCITY	WIND DIRECTION	WIND VELOCITY	AIR TEMP °C	WATER TEMP °C	VEGETATION	REMARKS	CONTINUATION
YEAR	MO	DAY																				

COMMENTS:

SPECIES CODE
1. GOLDEYE
2. NORTHERN PIKE
3. LAKE WHITEFISH
4. WALLEYE
5. LONGNOSE SUCKER
6. WHITE SUCKER
7. NINESPINE STICKLEBACK
8. TROUT-PERCH
9. EMERALD SHINER
10. SPOTTAIL SHINER
11. FLATHEAD CHUB
12. BURBOT

FIGURE 6. Data Sheet Used to Record Trawl Net Catches.

Seattle) that was fitted with either a 2.5- or a 3.8-cm needle. Tags were inserted on the left side of the fish and anchored between the pterygiophores below the dorsal fin in order to minimize loss of tags (Dell 1968). Only those fish that appeared to be in good condition were tagged and released.

Fish tagged in 1976 (Kristensen and Summers 1978), 1977 (Kristensen 1978; Summers 1978) and 1978 were recaptured in 1978 by commercial and domestic fishermen, anglers, Alberta Oil Sands Environmental Research Program (A.O.S.E.R.P.) fisheries biologists and LGL biologists. Tags were returned on a voluntary basis--no reward was offered.

Determination of Sex and State of Sexual Maturity

The sex and state of sexual maturity of almost all walleye captured were determined by either gently stripping a few eggs from females or extruding a small amount of milt from males. If eggs or milt could not be obtained through gentle pressure, walleye were sacrificed and gonads were examined. The sex and state of sexual maturity were not determined for 15 of the 1,271 walleye captured during this study.

The ovaries of numerous mature walleye were collected in the field and preserved in 10% formalin. The fecundities of 17 mature walleye were subsequently estimated by counting 1000 eggs from each ovary, weighing the 1000 eggs, weighing all of the eggs in the ovary, and then multiplying the 1000 eggs by the ratio of total egg weight to weight of 1000 eggs. The mean egg diameter for each of the 17 ovaries was determined by measuring the length of 30 damp-dried eggs placed in a row and dividing this quantity by 30.

Commercial Fishery

During the commercial walleye fishery conducted from 2-29 June 1978 in the vicinity of Big Point (see Figure 2), tags were collected from commercial fishermen. Fork lengths were recorded and pelvic fins were

removed, for subsequent age analysis, from 20 walleye (captured by commercial fishermen) per day on 16 of the 28 days of the commercial fishery (total of 320 samples). Commercial fishermen were restricted to using 11.4-cm mesh gill nets.

Age Determination

Pelvic fin rays were used to determine ages of walleye because of problems encountered collecting, preparing, and/or reading scales, dorsal fin rays and otoliths of walleye from the Peace-Athabasca Delta (Ott and Sekerak 1976; Kristensen and Summers 1978; G.W. Clarke pers. comm.). K.G. Dietz (pers. comm.) has had success using pelvic fin rays to determine ages of walleye from Lesser Slave Lake (see Figure 1).

The first two pelvic fin rays on the left side of fish were removed with wire cutters. If fish were alive, care was taken not to cut into the muscle tissue surrounding the base of the pelvic fin, but yet to cut the rays off close to the body in order to obtain as much of the proximal portion of the fin rays as possible.

A representative subsample of 197 sets of pelvic fin rays collected from the Richardson Lake/Jackfish Creek area between 19 and 28 May 1978, seven collected from other sampling areas between 19 May and 4 June, and a representative subsample of 100 pelvic fins collected from the commercial fishery between 2 and 29 June were immersed in epoxy glue which was permitted to dry and harden. Four to five sections (each approximately 0.5 mm thick) were then cut from the proximal end of the fin rays with a jeweller's saw (8/0 blade). It was essential to cut the sections perpendicular to the longitudinal axis of the fin rays. Sections were placed on glass slides in the order in which they were cut and were covered with Pro-texx mounting solution. The prepared sections were then viewed with a Bausch and Lomb dissecting microscope (25-30 power), through use of transmitted light. Annuli were counted on the first pelvic fin ray (the short, thick and hard spine). Care was taken to include recent growth and appropriate estimates of age were assigned to fin rays.

RESULTS AND DISCUSSION

Hydrological Conditions

As reported by Dietz (1973), because most of Richardson Lake freezes to the bottom during winter, the timing of ice lift and breakup in Richardson Lake is critical to the movement of mature walleye onto their spawning grounds. As the water levels in the Athabasca River increase during spring runoff, water flows toward Richardson Lake through Jackfish Creek and eventually physically lifts and breaks the ice on the lake. Ice lift and breakup occur in a similar manner in Mamawi Lake and Lake Claire (both lakes usually freeze to the bottom during late winter [Donald and Kooyman 1977]) as Peace River flood waters flow into Mamawi Lake through the Chenal des Quatre Fourches and into Lake Claire primarily through the Prairie River (see Figure 2).

During an ice-survey flight over the Delta on 1 May 1978 by Alberta Environment, the following ice conditions were noted (S. Flett pers. comm.): large pans of broken ice were starting to move in the Athabasca River, Jackfish Creek, Fletcher Channel and Embarras Channel; ice-cover was still complete on Richardson Lake, Mamawi Lake, Lake Claire, the Peace River, and the Rivière des Rochers between Fort Chipewyan and Little Rapids. There were a few openings in the ice on the Revillon Coupé. By 4 May, the ice had broken in Lake Athabasca adjacent to Fort Chipewyan, on the Peace River, the Rivière des Rochers, the Revillon Coupé, and at Quatre Fourches (S. Flett pers. comm.). On 15 May there was no ice on Limon and Blanche lakes, approximately one-quarter of Richardson Lake was ice-covered, one-half of Mamawi Lake was ice-covered and open water was visible only along the shorelines of Lake Claire (L. Yanick pers. comm.). By 19 May, Richardson Lake was ice-free and by 1 June, Lake Claire and Mamawi Lake were ice-free.

Water level recorders were installed by Alberta Environment personnel at numerous locations throughout the Delta after the majority of the ice had melted. Mean daily water levels at Richardson Lake, near Quatre

Fourches and at Lake Claire from 19 May-31 July 1978 are shown in Figure 7. Major runoff periods in the Athabasca River, as indicated by water levels at Richardson Lake, occurred on 25 June and 22 July. Peaks in runoff in the Peace River, as indicated by water levels in the Mamawi Lake channel, were not as pronounced and water levels were not as high as in the Athabasca River. The dampening effect of the Bennett Dam on water levels in the Peace River is clearly evident from water levels in the Mamawi Lake channel (Figure 7). Water levels in Lake Claire fluctuated widely over the short-term--this was, in part, due to the wind-created seiches on this large waterbody.

During the open-water gill netting period between 19 May and 4 June 1978, water levels in Richardson Lake and the Mamawi Lake channel were increasing, while those at Lake Claire were decreasing (Figure 7). During the period when Y-O-Y walleye were being sampled between 23 June and 11 July, water levels at Richardson Lake rose dramatically then decreased rapidly; water levels in the Mamawi Lake channel fluctuated moderately and those at Lake Claire fluctuated widely during this period.

Distribution, Abundance and Movement of Fish Based on Gill Net Catches

Catch Rates

Walleye

Approximately 41% of the fish captured between 9 April and 4 June 1978 were walleye and approximately 94% of these were captured in Richardson Lake and Jackfish Creek (Table 1). Walleye contributed from only 0% (Blanche Lake and Prairie River) to approximately 11% (Quatre Fourches) of the total catches in other areas. Walleye also did not contribute significantly to total catches obtained in 1976 (Kristensen and Summers 1978) or in 1977 (Kristensen 1978)--1.7% in both years--in the Peace-Athabasca Delta, excluding Richardson Lake and Jackfish Creek.

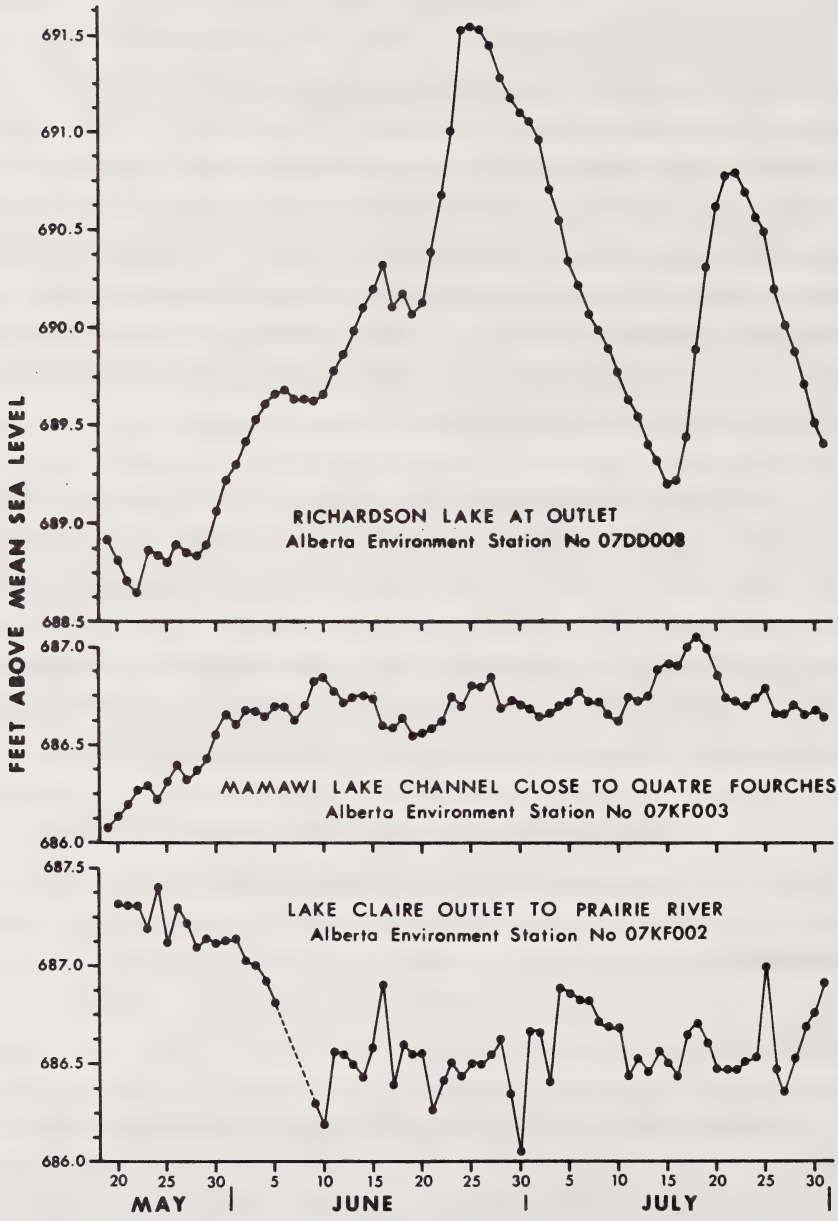

FIGURE 7. Water Levels at Richardson Lake, near Quatre Fourches and at Lake Claire, 19 May - 31 July 1978. (Data provided by Alberta Environment.)

TABLE 1. Numbers of Fish Captured in Gill Nets and Tagged and Released within the Peace-Athabasca Delta, 1978.

Species		Sampling Area[1]										
		A	C	H	J	K	L	M	P	Q	S	Total
Walleye	Captured	12	4	0	397	3	803	5	0	46	1	1271
	Tagged and released	8	2	0	351	0	638	4	0	32	0	1035
Goldeye	Captured	61	186	0	293	54	29	177	0	101	23	924
	Tagged and released	53	174	0	174	50	24	130	0	54	20	679
Northern pike	Captured	31	75	7	73	12	24	14	14	158	1	409
	Tagged and released	23	56	5	67	12	24	11	9	10	1	218
Lake whitefish	Captured	17	8	9	84	68	125	5	0	41	6	363
	Tagged and released	0	2	6	47	10	55	1	0	1	5	127
Longnose sucker	Captured	14	4	0	7	0	0	1	0	24	0	50
	Tagged and released	2	4	0	7	0	0	1	0	0	0	14
White sucker	Captured	2	1	0	9	0	0	0	0	3	0	15
	Tagged and released	1	1	0	9	0	0	0	0	0	0	11
Burbot	Captured	3	3	0	0	0	2	0	0	38	0	46
	Tagged and released	2	3	0	0	0	2	0	0	1	0	8
Flathead chub	Captured	0	0	0	0	0	0	9	0	0	0	9
	Tagged and released	0	0	0	0	0	0	8	0	0	0	8
Total	Captured	140	281	16	863	137	983	211	14	411	31	3087
	Tagged and released	89	242	11	655	72	743	155	9	98	26	2100

[1] A = Lake Athabasca
C = Lake Claire
H = Blanche Lake
J = Jackfish Creek
K = Limon Lake
L = Richardson Lake
M = Mamawi Lake
P = Prairie River
Q = Quatre Fourches
S = Richardson River

Mean daily catch rates of walleye varied from 15.89 to 5.27 fish/gill net gang/hour in Jackfish Creek from 9-17 April (Figure 8 and Appendix 1)--all captured walleye were mature (see Table 4). Mean daily catch rates in other sampling areas during this period were much lower, varying from 0.00 to 0.55 walleye/gill net gang/hour. On the basis of catch rates from 9-17 April, it appears that there were large numbers of walleye on their way to spawn in Richardson Lake and relatively few in the other locations sampled. However, catches in other locations do indicate that some walleye occurred in the Delta, other than in the Richardson Lake area, during the under-ice gill netting period in 1978. Walleye captured at Quatre Fourches may have been moving toward the Claire-Mamawi lakes system to spawn. It is not known if those walleye caught in Lake Athabasca spawned in that waterbody or if they were migrating to some other area. No walleye were captured in the Prairie River from 9-17 April but it should be noted that fishing was conducted in this river for only two days (Figure 8).

The marked decrease in walleye catch rates in Jackfish Creek from 11-15 April (Figure 8) may have indicated the movement of major concentrations of walleye into Richardson Lake to spawn. (This is based on the assumption that the ice on Richardson Lake had lifted sufficiently to allow fish to enter the lake.) Summers (1978) suggested that a major movement of mature walleye occurred through Jackfish Creek during mid-April 1977.

Walleye catch rates between 19 and 29 May in Richardson Lake were high, varying from 1.98 to 34.93 fish/gill net gang/hour (Figure 8 and Appendix 1). Peak catch rates were obtained in Richardson Lake in 1977 (Summers 1978) and in 1978 on 20 May. High catch rates of walleye in Richardson Lake suggest that there were still large numbers of walleye present there during late May 1978. However, during the same period, catch rates in Jackfish Creek (Figure 8) suggest that there was some movement of walleye from Richardson Lake toward Lake Athabasca. Results of Summers (1978) suggest a peak movement of walleye from Richardson Lake about 1 June 1977.

Although walleye were captured in Limon Lake, Richardson River, Lake Claire, Mamawi Lake, Lake Athabasca and at Quatre Fourches from 27 May-4

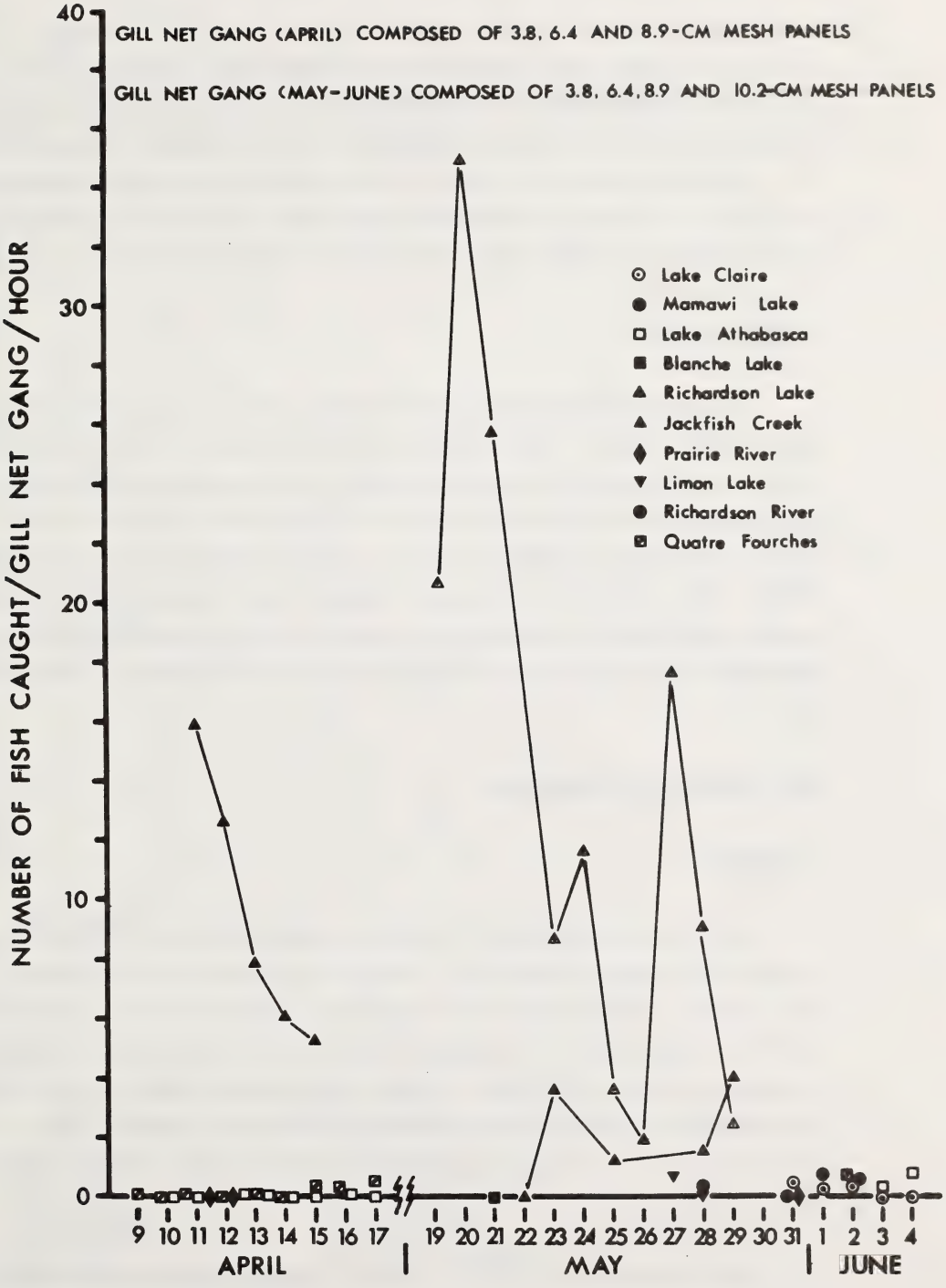

FIGURE 8. Mean Daily Catch Per Unit Effort for Walleye Captured with Gill Nets in the Peace-Athabasca Delta, 9 April - 4 June 1978.

June 1978, catch rates were very low (Figure 8). Limited spawning appears to have occurred in the Claire-Mamawi lakes system, in Limon Lake and perhaps along the northern shoreline of Lake Athabasca. Because no walleye were captured in Blanche Lake in 1978, walleye probably did not spawn in that lake. (A domestic fisherman and trapper [R. Armit], residing at Blanche Lake, informed us that only rarely did he capture walleye in his gill nets.)

Other Species

Goldeye predominated in total catches obtained from Lake Athabasca, Lake Claire, Mamawi Lake and the Richardson River in 1978 (Table 1). This species comprised 79.4% of over 24,000 fish captured in 1976 (Kristensen and Summers 1978) and 78% of close to 10,000 fish captured in 1977 (Kristensen 1978) in the Peace-Athabasca Delta, excluding Richardson Lake and Jackfish Creek. Lake whitefish (*Coregonus clupeaformis*) predominated in catches obtained from Blanche Lake and Limon Lake, and northern pike (*Esox lucius*) comprised the highest percentage of the catch from Quatre Fourches (Table 1).

Mark-Recapture Information

Walleye

Eighty-one percent of the walleye captured during this study were tagged and released (Table 1). During the under-ice gill netting period (9-17 April), 328 walleye were tagged and released at the confluence of Jackfish Creek and the Athabasca River and 32 walleye were tagged and released at Quatre Fourches. Because no walleye tagged in 1978 were recaptured by LGL biologists in known or potential spawning areas, it was not possible to estimate the number of walleye that spawned in various Delta areas in 1978.

The recaptures in 1978 of walleye tagged in 1976 (Kristensen and Summers 1978), 1977 (Kristensen 1978; Summers 1978) and 1978 are summarized by year of tagging in Table 2. The high proportion (87.5%) of walleye tagged from

TABLE 2. Movement of Fish Tagged in the Peace-Athabasca Delta in 1976, 1977 or 1978 and Recaptured in 1978.

Location[1] of Tagging	Location[1] of Recapture	Tagged in 1976[2]					Tagged in 1977[3]				Tagged in 1978[4]			
		W[5]	G	NP	LW	LS	W	G	NP	LW	W	G	NP	LW
River to Lake														
E	A	-	2	-	1	-	-	-	1	-	-	-	-	-
J	A	-	-	-	-	-	-	-	-	-	8	-	-	-
Q	A	-	5	1	1	1	2	2	1	-	3	-	-	-
R	A	3	3	3	2	-	-	-	2	-	-	-	-	-
E	C	-	-	-	-	-	-	1	-	-	-	-	-	-
P	C	-	-	-	-	-	-	-	-	-	-	-	1	-
R	C	-	1	-	-	-	-	-	-	-	-	-	-	-
Q	K	-	1	-	-	-	-	-	-	-	-	-	-	-
E	M	-	-	-	-	-	-	1	-	-	-	-	-	-
Q	M	-	-	-	-	-	-	1	-	-	-	-	-	-
Lake to Lake														
C	A	1	-	-	-	-	-	-	-	-	-	-	-	-
K	A	-	-	-	-	-	-	-	-	-	-	-	-	1
L	A	-	-	-	-	-	-	-	-	-	15	-	-	-
L/J	A	-	-	-	-	-	17	-	-	-	-	-	-	-
M	A	-	-	-	-	-	-	-	-	-	-	1	-	-
River to River														
Q	D	-	2	-	-	-	-	-	-	-	-	-	-	-
R	D	-	2	7	1	-	-	-	-	1	-	-	-	-
E	J	-	2	-	-	-	-	-	-	-	-	-	-	-
R	J	-	1	-	-	-	-	-	-	-	-	-	-	-
E	P	-	-	-	-	-	-	1	-	-	-	-	-	-
E	Q	-	-	-	1	-	-	-	-	-	-	-	-	-
Q	Q	-	1	-	1	-	-	-	-	-	-	-	-	-
R	Q	-	1	1	2	-	-	-	-	-	-	-	-	-
E	R	-	-	-	-	-	-	1	-	-	-	-	-	-
Lake to River														
C	D	-	1	-	-	-	-	-	-	-	-	-	-	-
L	J	-	-	-	-	-	-	-	-	-	1	-	-	-
L/J	J	-	-	-	-	-	5	-	-	-	-	-	-	-
C	Q	-	-	-	1	-	-	-	-	-	-	-	-	-
L/J	Q	-	-	-	-	-	1	-	-	-	-	-	-	-
M	Q	-	-	1	1	-	-	-	-	-	-	-	-	-
Total		4	22	13	11	1	25	7	4	1	27	1	1	1

[1] A = Lake Athabasca
C = Lake Claire
D = Peace River
E = Revillon Coupé
J = Jackfish Creek
K = Limon Lake
L = Richardson Lake
L/J = Richardson Lake System
M = Mamawi Lake
P = Prairie River
Q = Quatre Fourches or Chenal des Quatre Fourches
R = Rivière des Rochers

[2] From Kristensen and Summers (1978).

[3] From Kristensen (1978) and Summers (1978).

[4] Does not include fish recaptured less than 24h after being tagged.

[5] W = walleye
G = goldeye
NP = northern pike
LW = lake whitefish
LS = longnose sucker

1976 to 1978 and recaptured in Lake Athabasca in 1978 is, in part, due to unequal recapture effort in different waterbodies--most of the Lake Athabasca recaptures (Table 2) were obtained by commercial fishermen at Big Point, but no commercial fishery existed in the other locations sampled. Of the walleye recaptured in Lake Athabasca, 81.6% were tagged in Richardson Lake and Jackfish Creek. However, 2.1%, 6.1% and 10.2% of the walleye recaptured in Lake Athabasca in 1978 were tagged in Lake Claire, the Rivière des Rochers and the Chenal des Quatre Fourches (including Quatre Fourches), respectively. Walleye tagged in these three areas, as well as in the Revillon Coupé, were also recaptured in Lake Athabasca in 1976 (Kristensen and Summers 1978) and/or 1977 (Kristensen 1978). These data indicate that walleye from areas other than Richardson Lake contribute to the commercial fishery in Lake Athabasca.

Three walleye tagged in 1972 by Dietz (1973) in Richardson Lake were recaptured in 1978--one at Big Point by a commercial fisherman, and two in Richardson Lake by LGL biologists. The latter two recaptures, together with the five walleye tagged in the Richardson Lake system in 1977 by Summers (1978) and recaptured in Jackfish Creek in 1978 (Table 2), indicate that at least some of the walleye that spawn in Richardson Lake home to the same spawning grounds from year to year. Such homing has already been documented for walleye in the Lake Michigan area (Crowe 1962). However, all walleye may not necessarily home to the same spawning grounds, as suggested by a walleye tagged in the Richardson Lake system in 1977 and recaptured at Quatre Fourches in early spring 1978 (Table 2). Walleye tagged in the Peace-Athabasca Delta have previously been reported to move great distances from their points of tagging (Dietz 1973; Kristensen and Summers 1978; Kristensen 1978), which may lead them to find other spawning grounds.

Other Species

The movement of fish--particularly goldeye--tagged in the Peace-Athabasca Delta has previously been discussed in detail by Kristensen and Summers (1978) and Kristensen (1978). Therefore, only brief comments follow

on several of the more interesting or, as yet, undiscussed types of movements indicated in Table 2. The first recapture of a goldeye in Limon Lake was obtained in 1978--a fish that had been tagged in the Chenal des Quatre Fourches in 1976. One goldeye that was tagged in 1976 in Lake Claire was recaptured in 1978 at Garden Creek on the Peace River (approximately 230 km upstream of the Peace River-Chenal des Quatres Fourches confluence) and another goldeye that was tagged in 1976 at Little Rapids was recaptured in 1978 at Big Slough on the Peace River (approximately 70 km downstream of Garden Creek). These two recaptures represent the westernmost movements upstream in the Peace River of goldeye tagged in the Peace-Athabasca Delta between 1976 and 1978. Interestingly, the goldeye recaptured at Limon Lake and at Garden Creek had been retained in a holding pen in 1976 after they had been tagged, in order to assess the short-term effects of handling and tagging (for details, see Kristensen and Summers [1978]).

Age Structure of Juvenile and Adult Walleye

The ages of 197 walleye captured in Richardson Lake and Jackfish Creek from 19-28 May 1978 were determined by counting annuli on cross-sections of the first pelvic fin ray. The numbers of 8- and 9-year-olds were about equal and together they comprised 63% of the total walleye sample obtained from this area (Table 3 and Figure 9). The youngest and oldest age groups represented in the samples were 6- and 13-year-olds, respectively. Sample sizes of females were too low to make valid comparisons between the age structures of females and males--females comprised between only 0 and 20.0% of the age groups in this sample (Table 3).

Eight- and 9-year-olds comprised approximately 68% of a walleye sample obtained from Richardson Lake in 1977 (Summers 1978) (Figure 9), which compares favourably with the percentage of the total 1978 sample that these two age groups comprised. However, 8-year-olds (members of the 1969 year class) comprised a higher percentage (55%) of the total catch in 1977 than did members of the same year class (9-year-olds) in 1978 (30.5% of the total catch). Natural mortality and mortality due to fishing could account

TABLE 3. Age, Sex, Length and Weight of Walleye Captured in Richardson Lake and Jackfish Creek, 19-28 May 1978.

Age Group	Sex	No. Fish	% of Total	% Females	Fork Length (mm) Mean	Fork Length (mm) Standard Deviation	Weight (g) Mean	Weight (g) Standard Deviation
6	M	2			366.5	30.4	496.0	140.0
	F	0			-	-	-	-
		2	1.0	0	366.5	30.4	496.0	140.0
7	M	13			387.8	31.8	606.2	245.4
	F	0			-	-	-	-
		13	6.6	0	387.8	31.8	606.2	245.4
8	M	56			410.0	28.3	718.5	156.4
	F	8			436.9	33.2	907.1	209.5
		64	32.5	12.5	413.3	30.1	742.5	174.0
9	M	48			414.5	28.4	758.3	158.3
	F	12			454.3	33.8	963.8	176.5
		60	30.5	20.0	422.5	33.4	799.4	180.6
10	M	29			431.8	32.8	872.0	214.0
	F	3			471.3	4.7	1181.0	58.8
		32	16.2	9.4	435.5	33.4	900.9	223.6
11	M	20			450.9	29.8	986.6	232.0
	F	2			488.0	4.2	1375.0	220.6
		22	11.2	9.1	454.2	30.4	1021.9	253.1
12	M	2			445.0	14.1	935.5	40.3
	F	0			-	-	-	-
		2	1.0	0	445.0	14.1	935.5	40.3
13	M	2			453.0	32.5	1006.0	220.6
	F	0			-	-	-	-
		2	1.0	0	453.0	32.5	1006.0	220.6

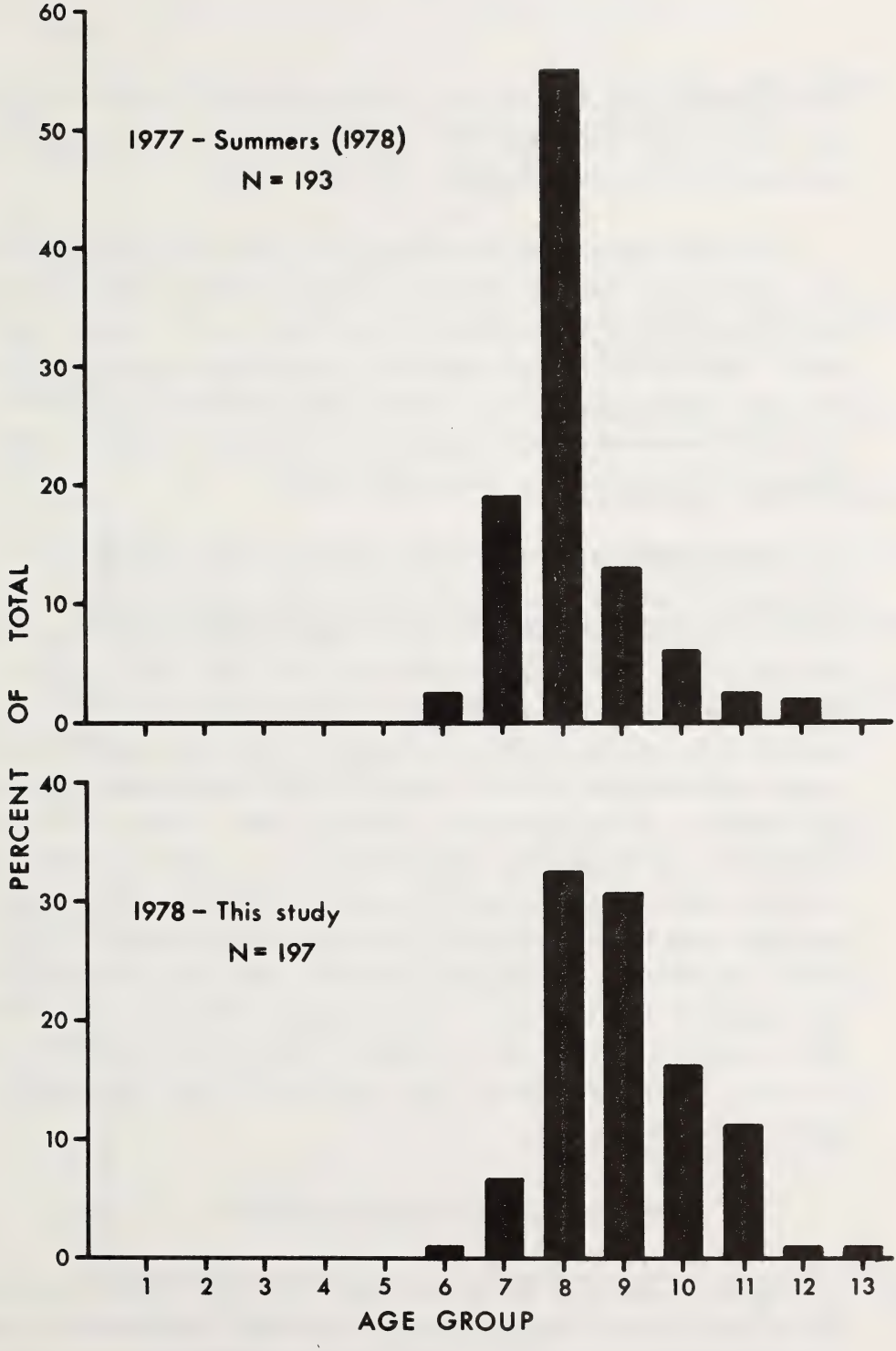

FIGURE 9. Age Structure of Walleye Captured in Richardson Lake and Jackfish Creek (Combined), April-June 1977 and 19-28 May 1978.

for the decline from 1977 to 1978 in the predominance of fish of the 1969 year class. Older age groups (9-, 10- and 11-year-olds) comprised higher percentages of the total sample in 1978 than in 1977.

Relatively few walleye were captured in areas other than Richardson Lake and Jackfish Creek in 1978--as a result, it was not possible to make valid comparisons of age structures of walleye from the various sampling areas. The ages and related statistics of seven walleye captured in areas other than Richardson Lake and Jackfish Creek are listed in Appendix 2. The age structure of walleye caught in the commercial fishery in Lake Athabasca is discussed in a subsequent section.

Although small or lacking sample sizes precluded comparisons of age structures of walleye from various areas within the Peace-Athabasca Delta in 1978, Kristensen and Summers (1978) compared age structures of walleye captured in 1976 with variable-meshed gill net gangs from the Claire-Mamawi lakes system, Lake Athabasca, the Chenal des Quatre Fourches, the Revillon Coupé and the Rivière des Rochers. There were marked differences in age structure among walleye sampled from the Claire-Mamawi lakes system, Lake Athabasca and the Rivière des Rochers. Four-, 5- and 6-year-olds predominated in the sample from Lake Athabasca; 5-, 6- and 7-year-olds comprised the majority of the catch from the Claire-Mamawi lakes system; and age groups were numerically evenly distributed in the sample from the Rivière des Rochers. The authors attributed these age structural differences among the sampling areas to differential commercial and/or domestic fishing pressure in these areas. Sample sizes of walleye from the Chenal des Quatre Fourches and the Revillon Coupé in 1976 were too small to make valid comparisons.

Growth of Juvenile and Adult Walleye

Growth, in terms of length and weight, of 6- to 13-year-old Richardson Lake walleye captured in 1978 appears to be nearly linear and is similar to the growth pattern of 6- to 12-year-olds from Richardson Lake in 1977 (Figure 10). A similar growth pattern of 6- to 11-year-old walleye from

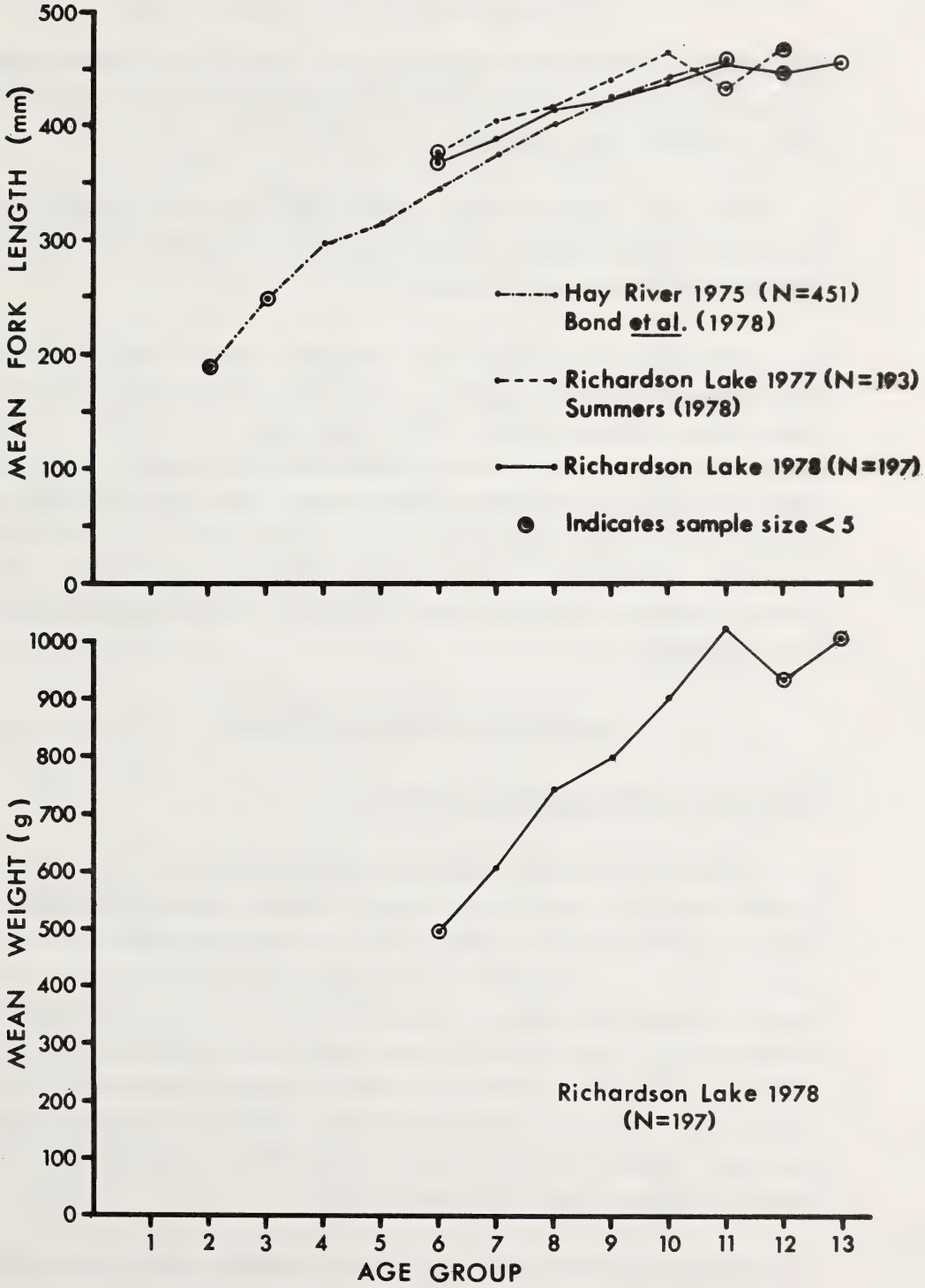

FIGURE 10. Age-Length Relationships for Walleye Captured in the Richardson Lake System and the Hay River, and Age-Weight Relationship for Walleye Captured in the Richardson Lake System.

the Hay River, N.W.T. was reported by Bond *et al.* (1978)--these authors indicated that walleye from the Hay River have one of the slowest growth rates reported in the literature for this species.

Within the same age groups, females were longer and heavier than males (Table 3). Female walleye usually exhibit faster growth rates than males (Bidgood 1971; Scott and Crossman 1973).

Although too few walleye were captured in areas other than Richardson Lake and Jackfish Creek in 1978 to make valid comparisons of walleye growth rates, Kristensen and Summers (1978) found that, for walleye 7 years old and older, growth rates were slower in the Rivière des Rochers than in Lake Athabasca or the Claire-Mamawi lakes system. These differences may have been a result of differential competition among fish due to differential commercial and domestic fishing pressure (Kristensen and Summers 1978), and also to differences among the times that fish from the various areas were captured.

Reproductive Parameters of Walleye

Sex Ratio and State of Sexual Maturity

Sex ratios of walleye captured during the under-ice gill netting period (9-17 April 1978) varied from 0% females at Quatre Fourches to 37.5% females in Lake Athabasca--sample sizes in these two areas were relatively small (Table 4). In Jackfish Creek, where the majority of the walleye were captured during this period, females comprised only 16.2% of the total walleye catch. All walleye captured during this period were sexually mature (Table 4). If male walleye in the Peace-Athabasca Delta move to the spawning grounds first, as discussed by Priegel (1970) for walleye in the Lake Winnebago region, it is possible that most females had not yet arrived in the Jackfish Creek area by 17 April 1978.

During the 19 May-4 June gill netting period, walleye sex ratios varied from 0% females in Mamawi Lake and the Richardson River, to 75% females in Lake

TABLE 4. Sex Ratios and Sexual Maturity of Walleye Captured in the Peace-Athabasca Delta during Spring 1978.

	9-17 April[1]		19 May-4 June	
Sampling Area	Male	Female	Male	Female
Richardson Lake	not fished			
Sample size			727	76
Sex ratio (%)			90.5	9.5
% mature			99.9	31.6
Jackfish Creek				
Sample size	280	54	18	44
Sex ratio (%)	83.8	16.2	29.0	71.0
% mature	100.0	100.0	100.0	22.7
Limon Lake	not fished			
Sample size			2	1
Sex ratio (%)			66.7	33.3
% mature			100.0	0.0
Richardson River	not fished			
Sample size			1	0
Sex ratio (%)			100.0	0.0
% mature			100.0	
Lake Athabasca				
Sample size	5	3	0	4
Sex ratio (%)	62.5	37.5	0.0	100.0
% mature	100.0	100.0		0.0
Lake Claire	not fished			
Sample size			1	3
Sex ratio (%)			25.0	75.0
% mature			100.0	100.0
Mamawi Lake	not fished			
Sample size			5	0
Sex ratio (%)			100.0	0.0
% mature			100.0	
Quatre Fourches				
Sample size	30	0	1	1
Sex ratio (%)	100.0	0.0	50.0	50.0
% mature	100.0		100.0	0.0

[1] The sexes of 15 walleye captured 9-17 April were not determined.

Claire--however, sample sizes were very small in these three areas (Table 4). Females comprised only 9.5% of the total walleye catch in Richardson Lake in 1978. Approximately 4.6% of the total walleye catch in Richardson Lake in May 1972 were females (Dietz 1973), while females comprised 37% of the catch in the same lake in May 1977 (Summers 1978). The 1972 and 1978 data suggest that female walleye do not remain on the spawning grounds as long as males do. This suggestion is substantiated by the high percentage (71%) of females moving through Jackfish Creek between 19 May and 4 June (Table 4), presumably leaving Richardson Lake and on their way back to Lake Athabasca. Priegel (1970) stated that female walleye enter the spawning area, spawn and leave immediately. Because females comprised a high proportion of the catch in 1977 (when compared with 1972 and 1978 sex ratios), fishing by Summers (1978) in 1977 presumably included the brief period when females were in the area.

Almost all male walleye, but only 31.6% of female walleye, captured in Richardson Lake in 1978 were mature (Table 4). Perhaps immature female walleye remain with the males in the lake longer than do mature females.

Fecundity

The mean egg count of 17 mature walleye captured in Richardson Lake between 19 and 27 May 1978 was 51,923, with a range in counts of 21,630 to 94,660 (Table 5). Dietz (1973) obtained a mean estimate of 57,572 eggs (range = 38,852-106,813) and Summers (1978) obtained a mean estimate of 54,000 eggs for Richardson Lake walleye. The mean egg diameter for the walleye sampled in 1978 was 1.51 mm (Table 5) and falls at the lower end of the range (1.5-2.0 mm) cited by Scott and Crossman (1973).

Lake Athabasca Commercial Fishery

Age Structure

The ages of 100 walleye captured by commercial fishermen in the vicinity of Big Point from 4-25 June 1978 were determined on the basis

TABLE 5. Fecundity and Related Statistics of Seventeen Mature Walleye Collected from Richardson Lake, 19-27 May 1978.

Fork Length (mm)	Weight (g)	Mean Egg Diameter (mm)	No. of Eggs (estimated)
422	822	1.53	41,100
425	822	1.50	43,150
425	907	1.57	51,110
430	765	1.50	32,430
430	822	1.37	48,600
430	1021	1.53	51,040
435	907	1.37	56,920
440	964	1.57	47,740
440	992	1.53	63,860
449	1162	1.60	49,770
450	1106	1.53	35,070
475	1191	1.57	67,860
480	1417	1.47	59,740
488	1503	1.50	74,280
491	1531	1.60	94,660
495	1191	1.40	43,730
497	1162	1.60	21,630
Mean 453	1076	1.51	51,923
Standard Deviation 27.8	239.5	0.07	17,114

of reading first pelvic fin ray cross-sections. (This sample was a temporally representative subsample of the original 320 walleye from which pelvic fins were removed.)

Eight- and 9-year-old walleye comprised 70% of the commercial sample (Table 6 and Figure 11). The same age groups also comprised 70% of a commercially-caught sample collected in the same area in 1977 (Summers 1978) (Figure 11); however, 8-year-olds were more predominant in the 1977 sample (59% of the total) than in the 1978 sample (41% of the total).

The walleye collected from the Lake Athabasca commercial fishery in Saskatchewan by Ott and Sekerak (1976) in 1975 were more evenly-distributed among the age groups than were the 1977 and 1978 samples (Figure 11). (Commercially-caught walleye from Big Point, Alberta were not sampled in 1975.) It should be noted that 11.4-cm mesh gill nets were used exclusively by fishermen in the three commercial fisheries discussed here. Five- and 6-year-old walleye (members of the 1970 and 1969 year classes, respectively) dominated the 1975 sample. These two year classes also dominated the 1977 sample as 7- and 8-year-olds, and the 1978 sample as 8- and 9-year-olds--an indication that walleye captured in both the Alberta and the Saskatchewan commercial fisheries are members of the same walleye group. This has already been demonstrated, particularly by Dietz (1973), who obtained many tag returns from the Saskatchewan commercial fishery of walleye tagged in Richardson Lake. It appears that the 1969 and 1970 year classes have been extremely important to the walleye fishery during the past three years.

Eight- and 9-year-old walleye dominated in both the Richardson Lake sample (see Figure 9) and the Lake Athabasca sample (Figure 11) in 1978. This supports the hypothesis (Bidgood 1973; Dietz 1973) that walleye that are captured in the commercial fishery at Big Point are part of the group that spawns in Richardson Lake.

TABLE 6. Age and Length of Walleye Captured by Commercial Fishermen at Big Point, Lake Athabasca, 4-25 June 1978.

Age Group	No. Fish	% of Total	Fork Length (mm)	
			Mean	Standard Deviation
6	2	2.0	378.5	54.4
7	18	18.0	388.9	22.2
8	41	41.0	414.4	33.7
9	29	29.0	431.4	25.1
10	8	8.0	438.9	33.3
11	0	0.0	-	-
12	1	1.0	462.0	-
13	1	1.0	425.0	-

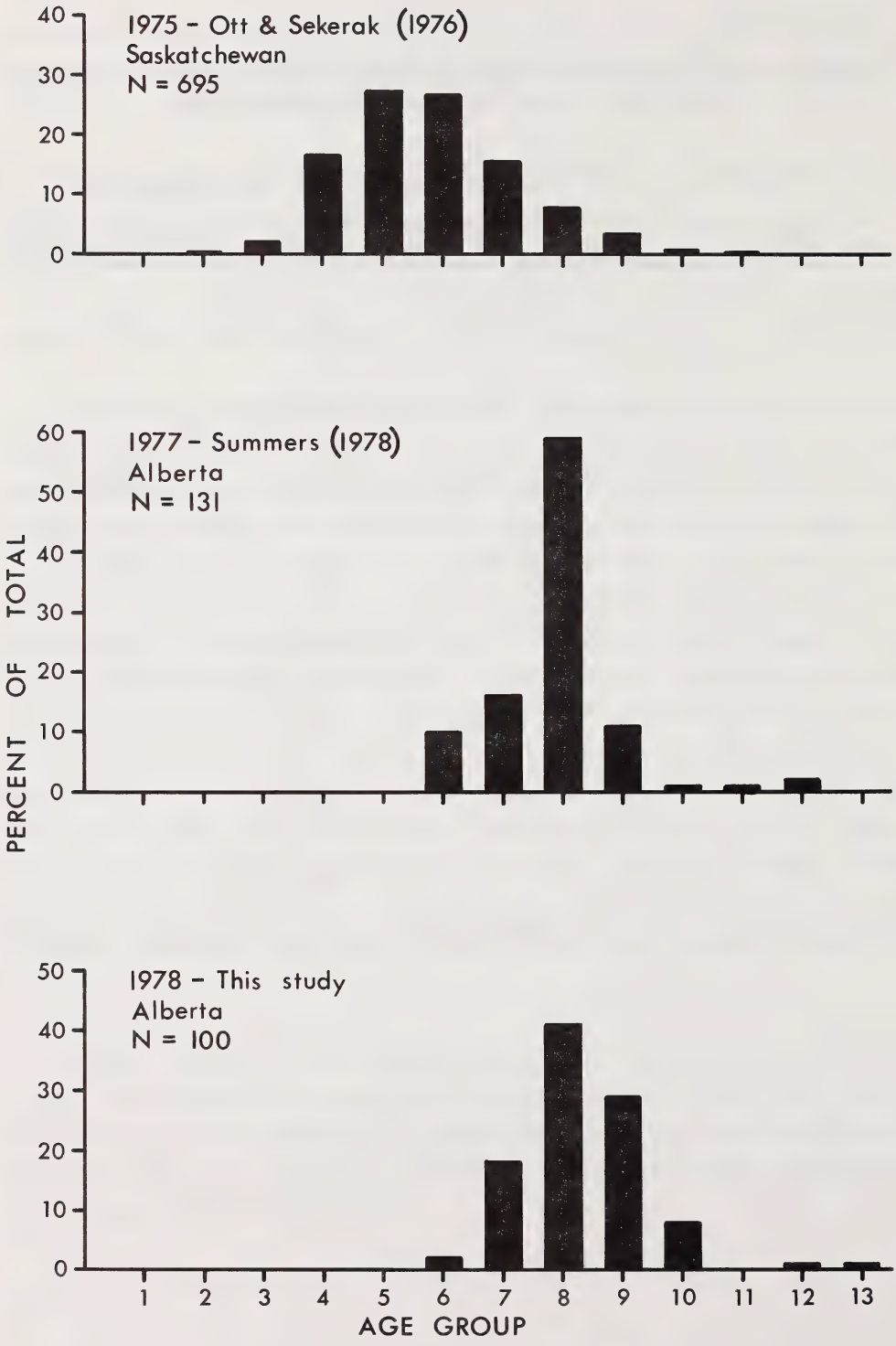

FIGURE 11. Age Structure of Walleye Captured in Lake Athabasca by Commercial Fishermen, 1975, 1977 and 1978.

Growth

In 1978, walleye (of all age groups except 13-year-olds) in the commercial sample from Lake Athabasca were larger than those in the sample obtained from Richardson Lake (Tables 3 and 6). This was not surprising because walleye were captured at Big Point three weeks later (on the average) than walleye in Richardson Lake--sufficient time within which to increase in length.

Growth curves for walleye captured in Saskatchewan in 1975 and in Alberta in 1978 (Figure 12) differ, probably because the Saskatchewan walleye sample was obtained later in the year (between 2 and 10 September 1975) than the Alberta sample (between 4 and 25 June 1978). The growth curve for walleye commercially-caught in Alberta in 1977 (Summers 1978) differs moderately from that of commercially-caught walleye in Alberta in 1978 (Figure 12)--both samples were obtained during approximately the same time of year. This difference was less apparent for walleye captured in Richardson Lake in 1977 and 1978 (see Figure 10). Such differences may be related to differences between the age determination techniques used in the two studies (scales were used in 1977; pelvic fin rays were used in 1978).

Commercial Exploitation Rate

Of the 989 walleye tagged in Richardson Lake or Jackfish Creek between 11 April and 29 May 1978, 23 (2.3%) were recaptured by commercial fishermen at Big Point between 2 and 29 June 1978--an exploitation rate (Youngs and Robson 1978) of 0.0233 with a variance of 2.3029×10^{-5}. Alberta commercial fishermen at Big Point in 1971 recaptured 5.0% of the 418 walleye tagged in the Richardson Lake system in the same year (Bidgood 1973). Commercial fishermen at Lake Athabasca in Alberta and Saskatchewan in 1972 recaptured 8.4 and 8.6%, respectively, of the 2,893 walleye tagged in Richardson Lake in 1972 (Dietz 1973). In 1977, commercial fishermen at Big Point recaptured 128 (25.2%) of the 508 walleye tagged in the Richardson Lake system (Summers 1978). Results of Bidgood (1973) in 1971, Dietz (1973) in 1972 and this study are comparable--it is not known why the exploitation rate in 1977 was so high.

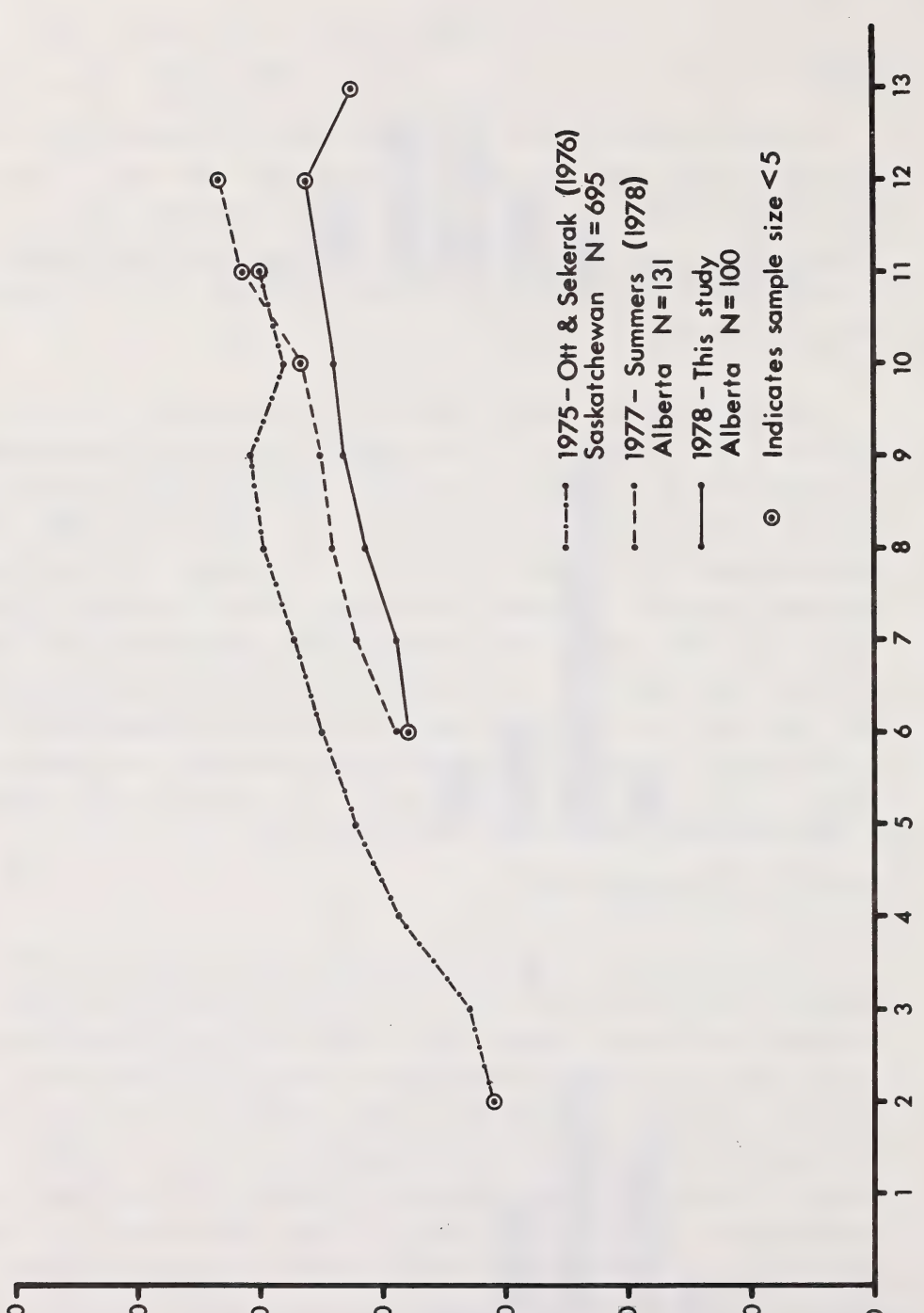

FIGURE 12. Age-Length Relationships for Walleye Captured in Lake Athabasca by Commercial Fishermen, 1975, 1977 and 1978.

Sixteen walleye tagged in the Richardson Lake system in 1977 (Summers 1978) were recaptured in 1978 by commercial fishermen at Big Point--3.1% of the original 508 walleye tagged in 1977. Of the 508 walleye tagged in 1977, 128 were removed by the 1977 fishery; therefore, a possible 380 tagged walleye remained immediately following the 1977 fishery at Big Point. Based on an assumed natural mortality rate of 30% between 1977 and 1978 (Schneider *et al.* [1977] suggested a 20-41% annual natural mortality rate for tagged walleye), there could have been 266 tagged walleye available to commercial fishermen at Big Point in 1978. If the above assumptions are correct, the recapture rate in 1978 of the remaining walleye tagged in 1977 would have been 16/266 = 6.0%. The actual recapture rate was probably higher than 6.0% because some of the walleye tagged in 1977 were likely also recaptured by commercial fishermen in Saskatchewan in 1977 and, therefore, fewer than 266 walleye would have been available to the 1978 fishery in Alberta.

The first-year exploitation rates of Richardson Lake walleye appear to vary markedly from year to year (5.0% in 1971 to 25.2% in 1977). In spite of an intensive annual commercial fishery, located at the mouth of the Athabasca River--the major river through which walleye exit from Richardson Lake--walleye in this system presently show no signs of overexploitation, as discussed by Spangler *et al.* (1977) for percids in general. Overexploitation usually results in increased growth rates of fish. On the basis of growth information reported by Bond *et al.* (1978) for Hay River walleye plus the similar growth rates of walleye from Richardson Lake and the Hay River, Richardson Lake walleye exhibit one of the slowest growth rates reported in the literature for this species. Also related to overexploitation is age at first maturity. As pointed out by Spangler *et al.* (1977), age at first maturity usually decreases in overexploited teleost populations, due to increased growth rates. The youngest male and female walleye captured in the Richardson Lake spawning grounds in 1978 were 6 and 8 years old, respectively. Scott and Crossman (1973) report that, generally, ages at first maturity are 2-4 years for male and 3-6 years for female walleye. This apparent late maturity of walleye in Richardson Lake would not suggest that they are being overexploited.

Of the 32 walleye tagged and released at Quatre Fourches between 9 April and 2 June 1978, three (9.4%) were recaptured by commercial fishermen at Big Point. Although the absolute number of walleye tagged at Richardson Lake and Jackfish Creek was approximately 31 times the number tagged at Quatre Fourches in 1978, the 1978 recapture rate by commercial fishermen of walleye tagged at Quatre Fourches was approximately four times that of walleye tagged in Richardson Lake and Jackfish Creek. These data support the contention that walleye from areas other than the Richardson Lake system are important to the commercial fishery.

Distribution, Abundance and Movement of Young-of-the-Year Walleye

Spawning grounds may be found not only by locating concentrations of mature walleye during the spawning season, but also by locating Y-O-Y walleye shortly following hatch, before they have grown large enough to swim great distances from their spawning grounds. Numerous waterbodies that were considered to be areas where walleye might spawn were sampled for Y-O-Y in 1978 (see Figure 5). These areas were selected, in part, according to where Kristensen (1978) had captured early-stage Y-O-Y walleye in 1977. In 1978, trawling was also conducted in Richardson Lake and Jackfish Creek in order to obtain catch rates of Y-O-Y walleye in these areas that could be compared with those obtained in other areas within the Delta. (Attempts were made to trawl in Limon Lake, but the water there was too shallow.)

A very high catch rate of 4.77 early-stage Y-O-Y walleye/net/min was obtained in Richardson Lake on 3 July 1978 (Table 7). On this date, Y-O-Y walleye were captured along the shorelines and in the centre of the lake. Relatively low catch rates of Y-O-Y walleye were obtained in Lake Claire, Lake Athabasca and Blanche Lake, whereas higher catch rates were obtained in Mamawi Lake during the 1978 sampling period (Tables 7 and 8 and Figure 13). Y-O-Y walleye catch rates in Lake Claire were higher in 1977 than in 1978 but were similar in Mamawi Lake in the two years (Table 8). Late June and early July catch rates

TABLE 7. Mean Catch Per Unit Effort for Young-of-the-Year Walleye in the Richardson Lake Area, 1978.

Sampling Area	Date	No. Sites	CPUE[1]	Standard Deviation	Variance
Jackfish Creek	25-26 June	11	1.90	1.57	2.47
	29 June	11	1.03	1.23	1.51
	30 June	11	0.18	0.14	0.02
	1 July	12	0.26	0.26	0.07
	2 July	11	0.24	0.21	0.04
	3 July	6	0.62	0.94	0.89
	7 July	6	0.50	0.38	0.15
Richardson Lake	27-29 June	9	0.17	0.32	0.10
	3 July	10	4.77	5.97	35.68
Richardson River	2-6 July	4	0.00	0.00	0.00
Blanche Lake	6 July	7	0.13	0.22	0.05
Athabasca River	6 July	12	0.00	0.00	0.00
Keane Creek	1 July	3	0.03	0.06	0.00
	6 July	3	0.00	0.00	0.00

[1] Numbers of walleye captured/(1m x 1m) trawl net/minute.

TABLE 8. Mean Catch Per Unit Effort for Young-of-the-Year Walleye in the Peace-Athabasca Delta (excluding the Richardson Lake area), 1977 and 1978.

Sampling Area	1977					1978				
	Date	No. Sites	CPUE[1]	S.D.[2]	Var.[3]	Date	No. Sites	CPUE	S.D.	Var.
Lake Claire	21-24 June	46	0.50	1.13	1.27	23-24 June	5	0.00	0.00	0.00
	5-8 July	45	0.27	0.53	0.28	29 June-3 July	44	0.09	0.33	0.11
	24-27 July	48	0.11	0.32	0.10	9-11 July	45	0.10	0.41	0.17
	23-27 Aug.	43	0.01	0.08	0.01					
Mamawi Lake	11 June	10	0.04	0.16	0.03	24 June	1	0.00	0.00	0.00
	1 July	10	0.33	0.55	0.30	1-2 July	10	0.54	1.05	1.10
	15 July	10	0.55	1.08	1.16	5-6 July	10	0.98	2.69	7.26
	23 July	4	0.00	0.00	0.00	9-11 July	9	0.37	0.35	0.12
	4 Aug.	10	0.04	0.16	0.03					
Lake Athabasca	27 June	12	1.39	2.88	8.32	25 June	2	0.00	0.00	0.00
	10-13 July	12	0.94	1.44	2.08	5 July	13	0.09	0.23	0.05
	18-20 Aug.	11	0.00	0.00	0.00					
Channels that connect Lake Athabasca and Mamawi Lake	13-18 June	11	0.07	0.31	0.10	1-2 July	11	0.23	0.57	0.32
	2-3 July	11	0.03	0.16	0.02	4 July	11	0.07	0.21	0.05
	15-16 July	11	0.07	0.21	0.05	6-8 July	11	0.03	0.16	0.02
	3 Aug.	11	0.00	0.00	0.00	9-11 July	10	0.32	0.55	0.31
Prairie River and tributaries	12 June	9	0.00	0.00	0.00	23-24 June	2	0.00	0.00	0.00
	28 June	10	2.76	6.88	47.30	1-2 July	12	0.27	0.56	0.31
	14 July	9	0.00	0.00	0.00	5 July	12	0.49	0.92	0.84
	2 Aug.	9	0.00	0.00	0.00	8-9 July	12	0.68	1.12	1.26
Birch River	22 June	5	0.00	0.00	0.00	30 June	5	0.00	0.00	0.00
	7 July	5	0.00	0.00	0.00	10 July	5	0.07	0.23	0.05
	25 July	5	0.00	0.00	0.00					
	24-25 Aug.	6	0.06	0.21	0.04					
Rivière des Rochers	19 July	15	0.02	0.13	0.02					
	14 Aug.	14	0.00	0.00	0.00					
Revillon Coupé	20 July	11	0.36	0.58	0.34					
	15 Aug.	10	0.04	0.16	0.03					
Chenal des Quatre Fourches	14 June	9	0.00	0.00	0.00					
	4 July	10	0.11	0.36	0.13					
	21 July	10	0.00	0.00	0.00					
	13 Aug.	10	0.04	0.16	0.03					
Baril River and Lake	28 July	8	0.05	0.18	0.03					
Mamawi Creek						11 July	2	0.00	0.00	0.00
Creek that connects Lake Claire and Baril Lake						11 July	2	0.00	0.00	0.00

[1] Number of walleye captured/(1m x 1m) trawl net/minute.

[2] Standard Deviation.

[3] Variance.

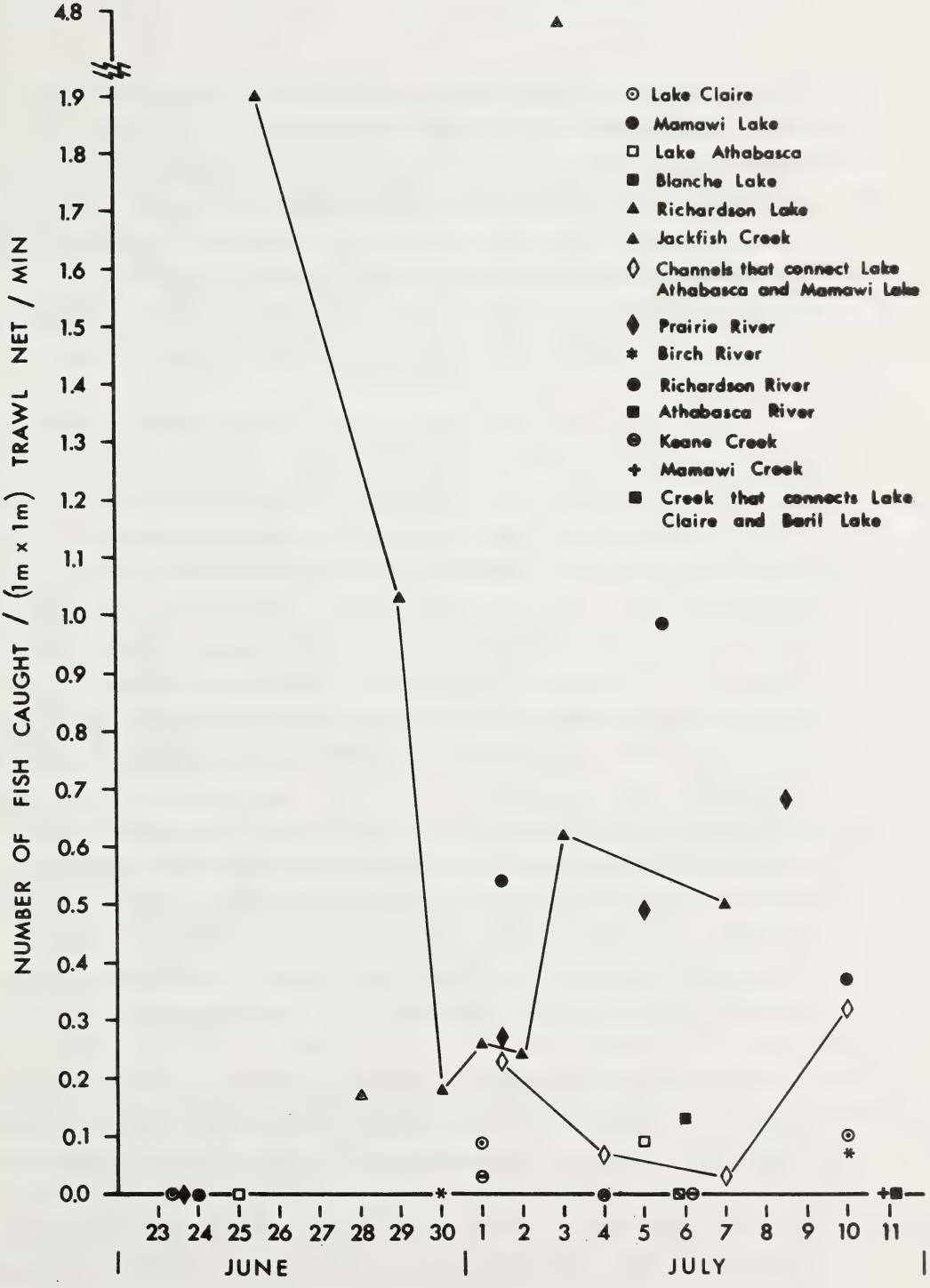

FIGURE 13. Mean Catch Per Unit Effort for Young-of-the-Year Walleye Captured with Trawl Nets in the Peace-Athabasca Delta, 23 June - 11 July 1978.

in Lake Athabasca (along the northern shoreline) were much higher in 1977 than in 1978. Based on the assumption that the catch rates of Y-O-Y walleye during late June and early July (shortly following hatch) indicated where spawning had occurred, moderate spawning took place in Lake Claire, Mamawi Lake, and along the northern shoreline of Lake Athabasca in 1977. Limited spawning occurred in Lake Claire, Lake Athabasca and Blanche Lake; moderate spawning occurred in Mamawi Lake; and intensive spawning took place in Richardson Lake in 1978.

The overall mean Y-O-Y walleye catch rates obtained in 1978 in Richardson Lake, Mamawi Lake and Lake Claire were 1.81, 0.66 and 0.09 fish/net/min, respectively. Although the overall Richardson Lake catch rate is approximately three times that from Mamawi Lake and 20 times that from Lake Claire, Mamawi Lake is approximately twice as large as Richardson Lake, and Lake Claire is about 19 times as large as Richardson Lake. On the basis of formulae used by Kristensen (1978) to obtain estimates of the numbers of postlarval Y-O-Y goldeye present in the Claire-Mamawi lakes system, approximately 1,512,000, 1,417,000 and 1,207,000 postlarval Y-O-Y walleye were produced in Richardson Lake, Lake Claire and Mamawi Lake, respectively, in 1978. These estimates were based on the assumptions outlined by Kristensen (1978), with one exception. Because high numbers of Y-O-Y walleye were captured in the centre, as well as along the shorelines, of Richardson Lake in 1978, the above estimates are based on the assumption that Y-O-Y walleye occurred throughout Lake Claire and Mamawi Lake as well, even though sampling in these waterbodies was conducted only along the shorelines.

As discussed by Donald and Kooyman (1977), when the variance in the numbers of organisms for a series of samples taken from a population is larger than the mean, the population is said to have a clumped distribution. Y-O-Y walleye exhibited this type of distribution in some areas on some dates in both 1977 and 1978 (Tables 7 and 8). This clumped distribution may be related to some environmental factors. Kristensen (1978) calculated Spearman rank correlation coefficients between fish catch rates and catch rates of other fish species, dominant shoreline

vegetation, water temperature, substratum material, substratum hardness, wind direction at lake sampling sites and waterbody type. These tests indicated that the distribution of Y-O-Y walleye, based on trawl net catches, was positively and significantly ($P<0.05$) correlated with the following:

1) the distribution of goldeye, longnose sucker (*Catostomus catostomus*), trout-perch (*Percopsis omiscomaycus*) and emerald shiner (*Notropis atherinoides*);
2) shoreline vegetation dominated by paper birch (*Betula papyrifera*);
3) relatively warm water temperatures;
4) a sand or rock substratum; and
5) a medium-hard to hard substratum.

Y-O-Y walleye distribution was negatively and significantly ($P<0.05$) correlated with the following:

1) the distribution of ninespine stickleback (*Pungitius pungitius*); and
2) waterbody type (i.e., catch rates were higher in lakes than they were in streams).

Dramatic movements of Y-O-Y walleye from Richardson Lake through Jackfish Creek have previously been documented (Dietz 1973; Ott and Sekerak 1976; Summers 1978). Catch rates in Jackfish Creek in 1978 (Table 7 and Figure 13) suggest that Y-O-Y walleye were leaving Richardson Lake at a relatively steady rate from 25 June-7 July. Peaks in the movement of Y-O-Y walleye in 1977 were on 27 June, 9 July and 19 July (Summers 1978). Ott and Sekerak (1976) reported peak numbers in Jackfish Creek on 23 July 1975 (sampling period from 18 July-10 August). Y-O-Y walleye captured in other rivers and creeks early in the 1977 and 1978 sampling periods (Tables 7 and 8) may also have been moving from areas within which they had hatched. However, they may have hatched in the watercourses in which they were captured--walleye spawn in other rivers in Alberta (e.g., the Athabasca River and/or its tributaries [Bond and Berry 1979]).

Size of Young-of-the-Year Walleye

Although precise hatch dates of walleye were not determined during this study, the relative sizes of postlarval Y-O-Y walleye captured from the various sampling areas shortly following hatch should indicate the relative timing of hatch. This contention is based on the assumption that growth rates of Y-O-Y walleye in various Delta waterbodies are similar. If this is true, data collected in 1978 suggest that Y-O-Y walleye captured in Richardson Lake, Jackfish Creek, Lake Athabasca (northern shore) and Blanche Lake hatched before walleye in the other sampling areas (Table 9 and Figure 14). Therefore, spawning apparently occurred in the above-mentioned areas earlier than in the other sampling areas. On the basis of similar data, Summers (1978) estimated that walleye spawned 10 days earlier in Richardson Lake than in other areas of the Delta in 1977. The timing of hatch in the various sampling areas is dependent on the timing of spawning which, in turn, is influenced by water levels and the timing of ice lifts and breakup during spring.

TABLE 9. Mean Total Lengths of Young-of-the-Year Walleye Captured in the Peace-Athabasca Delta, 25 June-11 July 1978.

Sampling Area	Date	No. Fish	Total Length (mm)	
			Mean	Standard Deviation
Prairie River and tributaries	1 July	7	23.1	2.54
	2 July	2	24.5	4.95
	5 July	16	29.4	2.94
	8 July	16	31.1	3.26
	9 July	6	29.7	2.88
Lake Claire	29 June	1	19.0	-
	30 June	7	19.6	1.27
	3 July	3	21.3	0.58
	9 July	4	27.0	2.94
	10 July	10	25.3	4.30
Birch River	10 July	1	24.0	-
Mamawi Lake	1 July	1	26.0	-
	2 July	11	25.1	2.66
	5 July	3	26.0	1.00
	6 July	24	31.5	2.86
	9 July	20	34.3	4.85
Channels that connect Lake Athabasca and Mamawi Lake	1 July	7	26.1	6.47
	4 July	1	25.0	-
	7 July	2	22.5	3.54
	8 July	1	18.0	-
	9 July	8	33.9	3.27
	11 July	12	36.2	7.79
Lake Athabasca	5 July	2	35.5	20.51
Richardson Lake	27 June	7	20.9	3.13
	29 June	12	23.9	3.18
	3 July	476	28.4	3.50
Blanche Lake	6 July	5	42.0	3.08
Jackfish Creek	25 June	274	26.0	3.76
	26 June	163	27.3	3.59
	29 June	124	26.1	5.05
	30 June	20	31.0	7.57
	1 July	31	29.4	7.51
	2 July	26	28.0	5.75
	3 July	37	28.8	3.81
	7 July	25	32.3	4.29

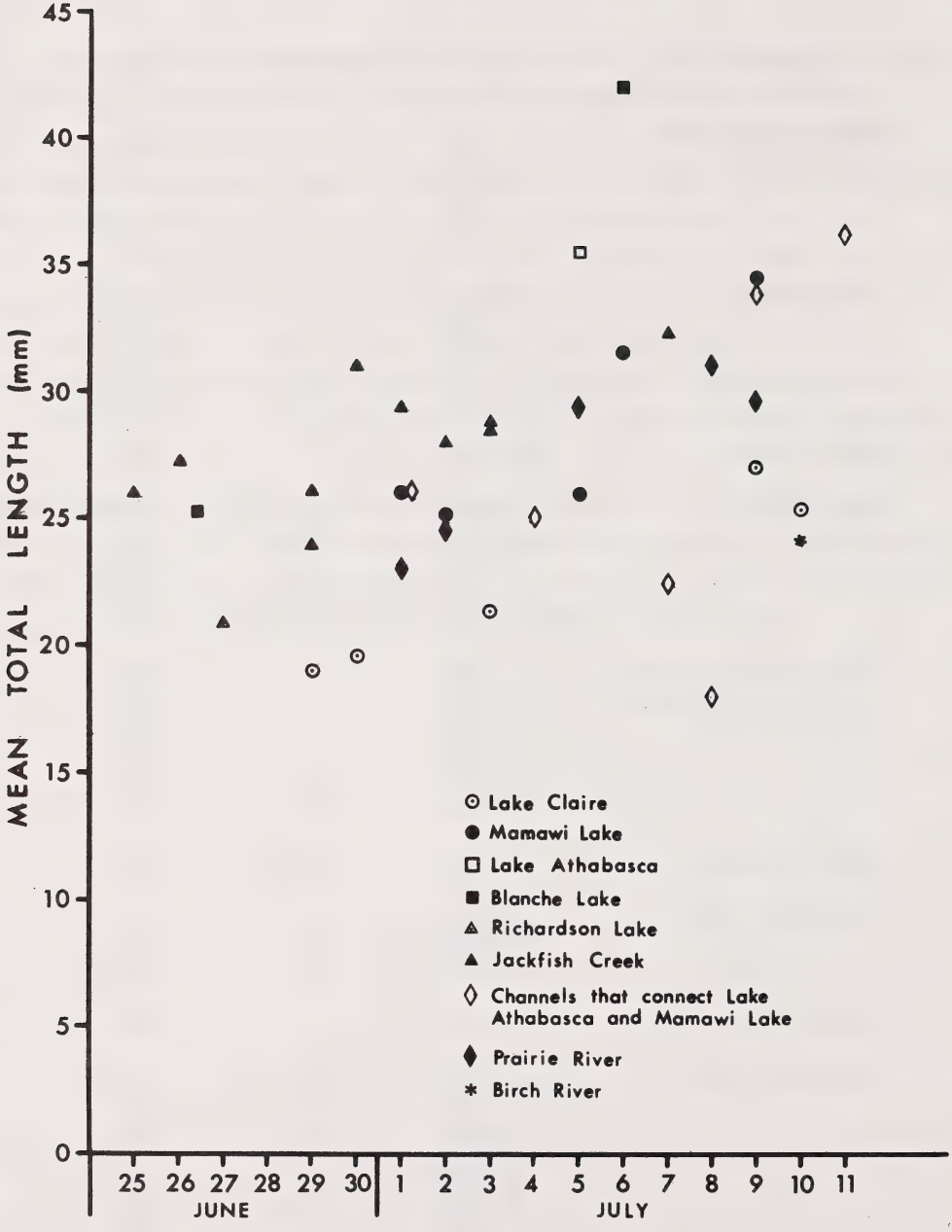

FIGURE 14. Growth of Young-of-the-Year Walleye Captured in the Peace-Athabasca Delta, 25 June - 11 July 1978.

CONCLUSIONS

Richardson Lake is known to be a major spawning area for walleye in the Peace-Athabasca Delta, including those that are captured in Lake Athabasca commercial fisheries in Alberta and Saskatchewan. Recent information (Kristensen 1978; Summers 1978) suggested that walleye also spawn in other areas of the Delta and that these walleye could contribute to the commercial fishery in Lake Athabasca (at least, in Alberta).

Low gill net catch rates of walleye in areas other than Richardson Lake and Jackfish Creek in 1978 suggest that walleye that spawned in these areas did not do so in as concentrated a manner as in Richardson Lake. Although very low absolute numbers of female walleye were captured in Limon Lake, Lake Claire, Mamawi Lake and along the northern shoreline of Lake Athabasca immediately following breakup, 50% of the walleye captured in these areas were females, compared with only a 9.5% female composition in Richardson Lake during the same period. The percentage of females that was mature in Richardson Lake between 19 May and 4 June 1978 was 31.6% while that in the other lakes sampled (combined) was 37.5%. Thus, although very few females were captured in areas other than the Richardson Lake area between 19 May and 4 June, females comprised a higher proportion of the total walleye catch from the other areas, and a higher proportion of these females were mature.

The absolute numbers of spawning walleye in areas other than Richardson Lake were probably quite high. For example, although catch rates of mature walleye in the Claire-Mamawi lakes system were much lower than those in Richardson Lake, the combined surface area of Lake Claire and Mamawi Lake is over 21 times that of Richardson Lake.

On the basis of the above information and the 1977 and 1978 recapture by commercial fishermen at Big Point of walleye tagged in the Claire-Mamawi lakes system or at Quatre Fourches, walleye that spawn in this system probably contribute substantially to the Lake Athabasca commercial fishery.

The fact that early-stage Y-O-Y walleye captured in the Claire-Mamawi lakes system were markedly shorter than those captured in the Richardson Lake area suggests that walleye from the two areas did not hatch during the same period. In other words, it is very improbable that the Y-O-Y walleye captured in the Claire-Mamawi lakes system originated from the Richardson Lake area, and strongly suggests that they hatched in the area from which they were captured--the Claire-Mamawi lakes system. Early-stage Y-O-Y walleye were also captured in Blanche Lake and along the northern shoreline of Lake Athabasca in 1978.

Although the estimates of postlarval Y-O-Y walleye produced in 1978 in Richardson Lake, Lake Claire and Mamawi Lake, based on trawl net catches, are tenuous, they are valuable in order to obtain some perspective on the relative importance of the various waterbodies to walleye spawning. Catch rates of Y-O-Y walleye in other areas were low in comparison to those obtained at Richardson Lake in 1978. However, if catch rates are extrapolated over surface area, Lake Claire, Mamawi Lake and Richardson Lake could have produced approximately 1.4 million, 1.2 million and 1.5 million Y-O-Y walleye, respectively. Therefore, the Claire-Mamawi lakes system could have produced approximately 1.7 times the number of walleye that Richardson Lake could have produced in 1978.

Fernet (1971) estimated the presence of approximately 435,000 Y-O-Y walleye in Lake Claire and Mamawi Lake in 1971 of which approximately 72% occurred in Mamawi Lake. Kristensen (1978) estimated that 1,705,000 and 219,000 Y-O-Y walleye were found in Lake Claire and Mamawi Lake, respectively, between 21 June and 1 July 1977. Estimates of these two researchers were based on the assumption that only the area within approximately 700 m of the shoreline was utilized by Y-O-Y walleye and would be approximately four and two times higher for Lake Claire and Mamawi Lake, respectively, if the total surface areas of these two lakes were considered, as in 1978. A comparison of the estimates of Y-O-Y walleye numbers in Lake Claire and Mamawi Lake in 1971, 1977 and 1978 suggests that production of Y-O-Y can vary substantially in these two lakes from year to year.

An estimated 2,500,000 Y-O-Y walleye were produced in Richardson Lake in 1975 (Ott and Sekerak 1976). Summers (1978) estimated that between 823,000 and 1,250,000 Y-O-Y walleye were produced in Richardson Lake in 1977. These estimates suggest that Y-O-Y production in Richardson Lake does not vary as markedly from year to year as it appears to in the Claire-Mamawi lakes system.

Some walleye that contribute to the commercial fishery at Big Point may spawn in areas other than within the Peace-Athabasca Delta. Bond and Berry (1979) reported that mature and Y-O-Y walleye were captured in 1976 in the Athabasca River between Fort McMurray and the Firebag River. Mark-recapture information (Kristensen 1978; Kristensen and Summers 1978) indicates that walleye move between the Peace-Athabasca Delta (including Lake Athabasca) and the Athabasca River (as far south as Fort MacKay). It is not known to what extent walleye that spawn upstream in the Athabasca River contribute to the Lake Athabasca commercial fishery.

Three walleye that were tagged in Lake Claire in 1976 were recaptured in February 1977 at the confluence of the Birch River and Modere Creek (Kristensen 1978). These fish were captured in large (11.4-cm) mesh nets and, in all probability, were mature individuals. Perhaps some of the walleye that spawn in Lake Claire overwinter in the Birch River and are therefore not available to the Lake Athabasca commercial fishery.

Information collected in 1978 indicates that walleye spawn and that young-of-the-year are successfully produced in several regions within the Peace-Athabasca Delta. Data obtained during this study and analyses of information reported in previous studies indicate that walleye produced in regions other than Richardson Lake contribute significantly to the commercial fishery in Lake Athabasca. However, for its size, Richardson Lake still appears to be the single most important waterbody for production of walleye in the Peace-Athabasca Delta.

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APPENDIX 1. Sex Ratios, Sexual Maturity, and Catch Per Unit Effort for Walleye Captured in the Peace-Athabasca Delta during Spring 1978.

Date	Sampling Area[1]	No. Males		No. Females		No. Not Sexed	Total Walleye	Total Mature	CPUE[2]
		Total	Mature	Total	Mature				
9 April	Q	2	2	0	0	0	2	2	0.08
10 April	Q	0	0	0	0	0	0	0	0.00
10 April	A	0	0	0	0	0	0	0	0.00
11 April	Q	0	0	0	0	1	1	0	0.04
11 April	J	94	94	26	26	0	120	120	15.89
11 April	A	0	0	0	0	0	0	0	0.00
11 April	P	0	0	0	0	0	0	0	0.00
12 April	Q	0	0	0	0	0	0	0	0.00
12 April	P	0	0	0	0	0	0	0	0.00
12 April	J	71	71	10	10	0	81	81	12.66
12 April	A	0	0	1	1	0	1	1	0.04
13 April	Q	1	1	0	0	0	1	1	0.04
13 April	J	48	48	7	7	0	55	55	7.89
13 April	A	0	0	1	1	0	1	1	0.03
14 April	Q	0	0	0	0	0	0	0	0.00
14 April	J	43	43	7	7	1	51	50	6.10
14 April	A	0	0	0	0	0	0	0	0.00
15 April	Q	14	14	0	0	6	20	14	0.39
15 April	J	24	24	4	4	0	28	28	5.27
15 April	A	0	0	1	1	0	1	1	0.01
16 April	Q	7	7	0	0	4	11	7	0.31
16 April	A	5	5	0	0	0	5	5	0.07
17 April	Q	6	6	0	0	3	9	6	0.55
17 April	A	0	0	0	0	0	0	0	0.00
19 May	L	152	152	15	15	0	167	167	20.66
20 May	L	261	261	2	2	0	263	263	34.93
21 May	L	67	67	0	0	0	67	67	25.73
21 May	H	0	0	0	0	0	0	0	0.00
22 May	J	0	0	0	0	0	0	0	0.00
23 May	L	7	7	5	1	0	12	8	8.65
23 May	J	2	2	15	2	0	17	4	3.64
24 May	L	50	49	12	5	0	62	54	11.66
25 May	J	1	1	4	0	0	5	1	1.28
25 May	L	3	3	3	1	0	6	4	3.65
26 May	L	2	2	5	0	0	7	2	1.98
27 May	L	135	135	31	0	0	166	135	17.79
27 May	K	2	2	1	0	0	3	2	0.70
28 May	L	44	44	1	0	0	45	44	9.19
28 May	J	1	1	5	3	0	6	4	1.51
28 May	K	0	0	0	0	0	0	0	0.00
28 May	S	1	1	0	0	0	1	1	0.36
29 May	L	6	6	2	0	0	8	6	2.50
29 May	J	14	14	20	5	0	34	19	4.06
31 May	M	0	0	0	0	0	0	0	0.00

APPENDIX 1. cont'd

Date	Sampling Area[1]	No. Males		No. Females		No. Not Sexed	Total Walleye	Total Mature	CPUE[2]
		Total	Mature	Total	Mature				
31 May	P	0	0	0	0	0	0	0	0.00
31 May	C	1	1	0	0	0	1	1	0.49
1 June	M	3	3	0	0	0	3	3	0.78
1 June	C	0	0	1	1	0	1	1	0.26
2 June	Q	1	1	1	0	0	2	1	0.73
2 June	M	2	2	0	0	0	2	2	0.59
2 June	C	0	0	2	2	0	2	2	0.33
3 June	A	0	0	2	0	0	2	0	0.31
3 June	C	0	0	0	0	0	0	0	0.00
4 June	A	0	0	2	0	0	2	0	0.78
4 June	C	0	0	0	0	0	0	0	0.00

[1] A = Lake Athabasca
C = Lake Claire
H = Blanche Lake
J = Jackfish Creek
K = Limon Lake
L = Richardson Lake
M = Mamawi Lake
P = Prairie River
Q = Quatre Fourches
S = Richardson River

[2] During April, CPUE = total no. of walleye caught/45.7-m net/hour; gill net gang composed of 3.8-, 6.4- and 8.9-cm mesh panels. During May-June, CPUE = total no. of walleye caught/61.0-m net/hour; gill net gang composed of 3.8-, 6.4-, 8.9- and 10.2-cm mesh panels.

APPENDIX 2. Ages and Related Statistics of Walleye Captured in Areas Other Than the Richardson Lake System, 19-28 May 1978.

Sampling Area	Sex	Age	Fork Length (mm)	Weight (g)
Limon Lake	M	7	428	737
Limon Lake	F	8	516	1332
Limon Lake	M	9	445	936
Richardson River	M	11	520	1503
Lake Claire	F	7	508	1389
Lake Claire	F	7	413	709
Lake Claire	F	8	530	1531